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# SURGERY OF THE THYMUS GLAND. THYMECTOMY. REPORT OF FIFTY OPERATED CASES

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Most of the surgery of the thymus gland up to the present has been concerned with the direct operative relief of tracheal and esophageal obstruction due to hypertrophy of the gland, the not infrequent cause of sudden death in infants. As this particular condition is practically limited to the period of infancy and early childhood, it follows that most of the operative work on this organ has been done during this early stage of growth; in fact, I am able to find the report of but one thymectomy performed on an adult. This one case will be considered more in detail in discussing the relation of the enlarged thymus to Graves' disease. The major portion of this paper will, therefore, be devoted to the thymus in infancy.

My attention as an operating surgeon was first called to this restricted but none the less promising field of recent surgical endeavor by seeing an infant in a ward of the Children's Memorial Hospital in this city in April, 1911, which was suffering from recurrent convulsive attacks, with cyanosis. The child was entered on the service of Dr. Frank S. Churchill, who called me in consultation and suggested the operative treatment.

## REPORT OF CASE

Roger S., male child, born May 1, 1910, entered service of Dr. F. S. Churchill, Children's Memorial Hospital, Chicago, April 28, 1911. The child had been in the hospital during the previous November and December for digestive disturbances and was discharged in good condition Jan. 1, 1911. It was brought to the hospital the second time, April 28, 1911, on the advice of Dr. Grace Meigs, with the complaint of convulsions the last two evenings, coming on irregularly and lasting five to ten minutes.

*Physical Examination* (by Dr. Churchill).—A well nourished child, head large, fontanel open, skin of face, chest, back, and to a slighter extent of the anal region, is red and covered with a fine maculo-papular eruption. Chest: Area of dulness over upper end of sternum, upper limit at first interspace, extends 1 cm. to right of median line and 3 cm. to left of median line and to lower limit of fourth interspace on left side. *X*-ray plates show a shadow which corresponds to the area of dulness over the thymus. (Fig. 1.)

May 24. Since admission child has averaged two to three convulsions a day. These convulsions vary in severity from slight rigidity lasting a few seconds to rigidity of the whole body lasting from five to ten minutes. Child very cyanotic during attacks. Attacks are apparently brought on by any disturbance of the child which causes him to cry; e. g., a bath or changing of linen. When not disturbed the child is free from symptoms. Child has a marked stridor, which is heard in practically all his crying spells.

I had been consulted during this time on the feasibility of removing a part or all of the thymus, as Dr. Churchill believed the condition of the child demanded it, not only on account of its present distress but for its future welfare. It was fully as much for the latter as for the former that I consented to operate, as he had not appeared in very serious straits at the times of quiescence when I had happened to see him.

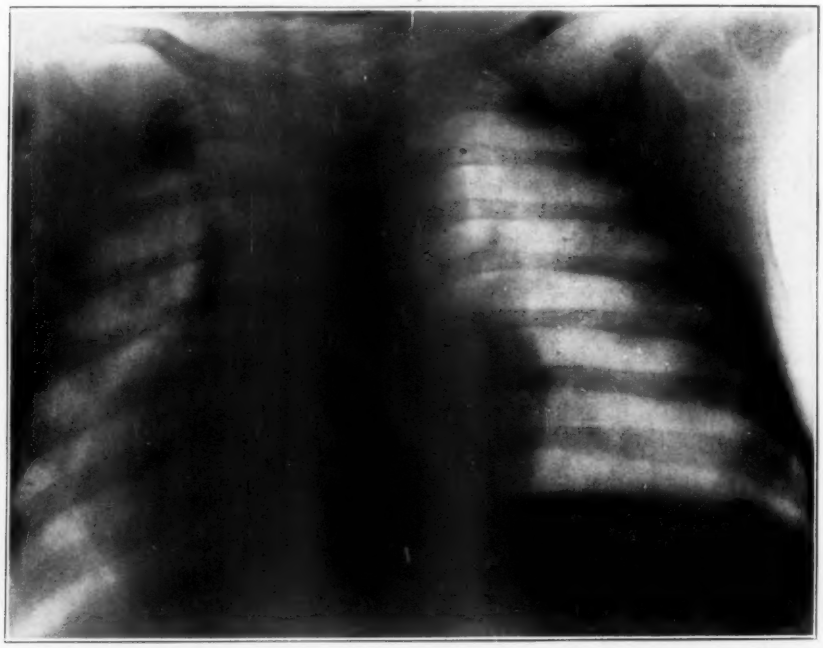

Fig. 1.—Radiograph taken before operation showing shadow of the thymus extending up from heart. Viewed from behind.

*Operation.*—May 25, under ether anesthesia, which caused no untoward symptoms, I removed a portion of the thymus about 5 cm. by 3 cm. wide and 1.5 cm. thick, weighing 9 gm. about a half hour later after having dried some in the air. At 10 p. m. the child had a convulsion lasting four minutes.

The plan of operation was that of Veau,[1] who has operated in more cases than any other surgeon. A median incision four to five cm. long was made in the middle line of the neck with its lower end just below the upper border of the sternum, and extending down to the deep fascia. (Fig. 4.) The sternal portions of the sternomastoid muscles appeared in the field. An incision of the deep cervical fascia exposed the sternothyroid muscles which were separated by incision and blunt dissection. This exposed the pretracheal tissues and in the lower part of

1. Veau and Oliver: Presse méd., 1910, xviii, 257.

the wound could be seen, rising and falling with each respiration, the upper portion of the thymus, resembling very closely in color and structure the omentum seen through a thin hernial sac. (Figs. 5, 6 and 7.) The gland when first seen was inside its capsule, which was lifted up with dissecting forceps and incised. Further resembling the omentum, the gland showed a tendency to herniate through the capsule at each expiration, when it was seized with forceps and gradually stripped of its investing sheath until the larger portion was extra thoracic, when it was tied off at its more fixed portion under the sterno-clavicular junction, where it is joined by the nutritive branches from the internal mammary artery. (Fig. 8.) Veau believes this precaution against hemorrhage unnecessary as it is sometimes impossible to apply the ligature on account of rupture of the gland, these cases having done just as well as others in which the ligature was applied. The wound was closed with deep sutures of catgut in the cervical structures and skin stitches of horse hair.

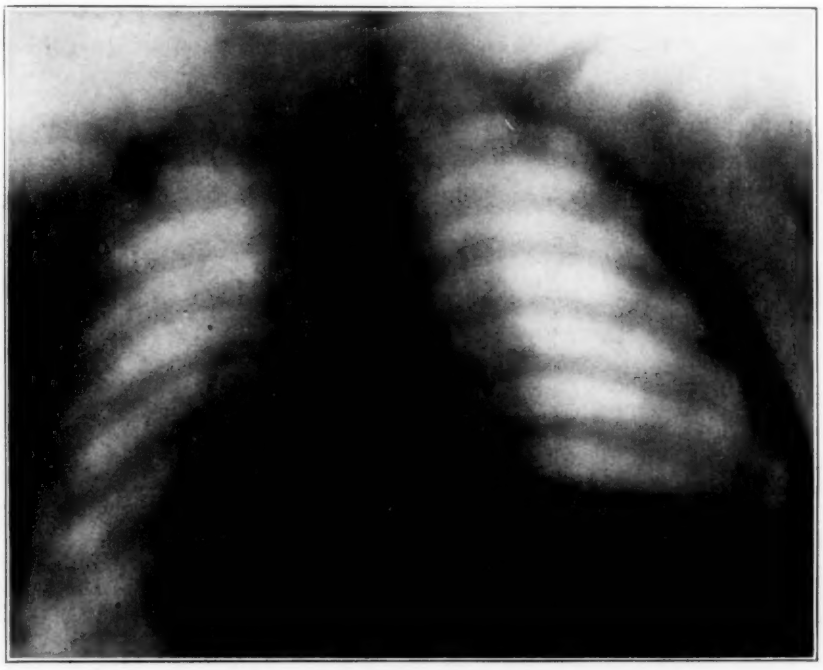

Fig. 2.—Radiograph taken after operation, showing smaller shadow above the heart in the region of the extirpated thymus. Viewed from behind.

*Subsequent History.*—The temperature, which was normal before the operation, became 102 F. a few hours afterward, and 105 the next day and the day following, when it gradually went down to normal at the end of the week. Two slight convulsions were also recorded during the week.

At the end of the week the lower part of the wound was found infected, but it drained well and caused no rise in temperature. The early and rapid rise I believe occurred too soon to be entirely due to infection.

June 9. The wound in the neck is practically healed. The child has had no convulsions for several days and has had no stridor since the operation, is bright and contented, eczema all cleared up, and appears like any perfectly normal, bright baby.

The photograph (Fig. 3) was taken June 9, two weeks after operation. The *x*-ray picture taken June 20 (Fig. 2), shows a decided change of lessened density in the region from which the thymus was removed.

PATHOLOGIST'S REPORT

*Operation, Thymectomy* (Pathologist, Dr. J. H. Hewitt).—The specimen consists of a grayish-white mass of tissue weighing about 9 grams, and measuring 4 by 6 by 1 cm. It is soft in consistency. It is divided into two lobes. The lobes are held together by connective tissue along one border. One of the lobes is further divided into two parts which are likewise held together by connective tissue bands along their lower border. The capsule is thin and transparent.

Sections show the tissue to be made up chiefly of lymphoid cells, which are divided by bands of connective tissue running in from the capsule into areas of various sizes but which show in general a regular arrangement of the elements. Along the outer border of these areas the lymphoid cells are densely packed. In the central portion of these areas the lymphoid cells are fewer in number and more loosely arranged. Here may also be seen blood-vessels whose walls are thick-

Fig. 3.—Photograph of child taken June 9, after operation, showing scar.

ened. There are also in these areas a certain number of corpuscles of epithelial cells. A certain number of these corpuscles show an infiltration with a variable number of leukocytes and lymphocytes. Some of these corpuscles (Hassall's) show deposits apparently of lime salts.

*Diagnosis.*—Normal thymus.

Figure 9 shows the patient October 31, five months after the operation. At this time Dr. Churchill examined the patient and reported him in excellent condition as the picture would suggest.

As the gland lies in front of all the important structures in the neck and thorax, the trachea, innominate artery and veins, as well as the heart and pericardium, these deeper structures were not interfered with in the enucleation, and indeed were not seen.

The child when seen a year after the operation was in excellent condition, although he had just passed through a severe siege of whooping-cough.

ANATOMY

The thymus gland is originally a bilaterally symmetrical organ derived embryologically as an evagination from the third visceral pouches, with the region of which it may in some cases remain permanently connected.[2] It attains its greatest development during the first two or three

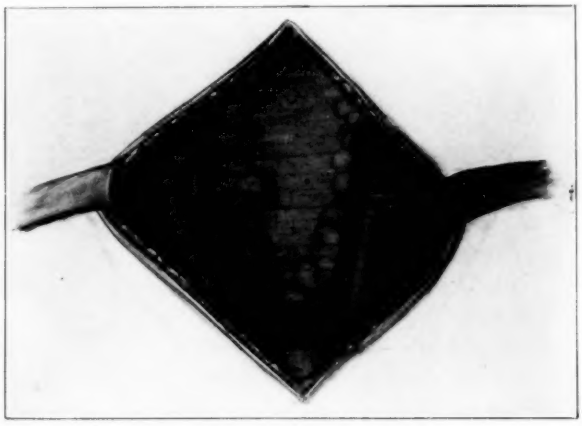

Fig. 4.—Modified from Veau. Showing the inner borders of the two sternomastoid muscles covered with the cervical fascia.

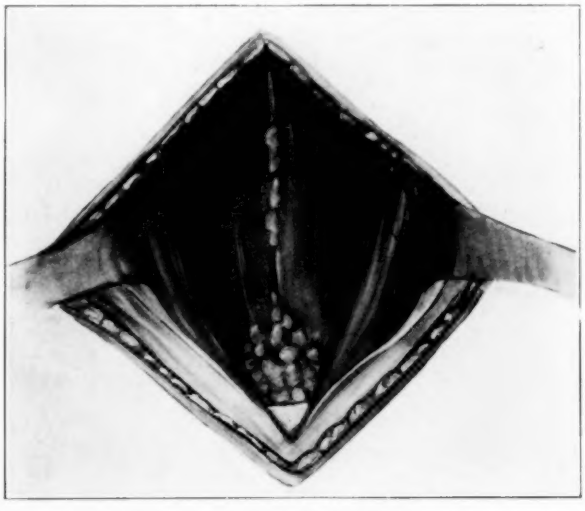

Fig. 5.—Modified from Veau. The deep cervical fascia is retracted showing the sternomastoid, the depressors of the hyoid, and the upper border of the manubrium sterni.

2. Biedl, A., in his recent work, "Innere Sekretionen, ihre physiologischen Grundlagen und ihre Bedeutung für die Pathologie," Wien, 1910, states that it is developed from the third, fourth and perhaps the second visceral clefts.

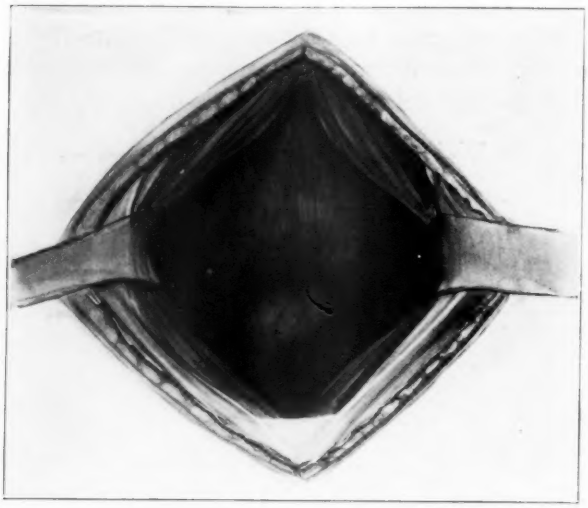

Fig. 6.—Modified from Veau. The depressors of the hyoid are retracted exposing the pretracheal fascia, in the lower portion of which appears the thymus in its capsule. This moves with the respiration.

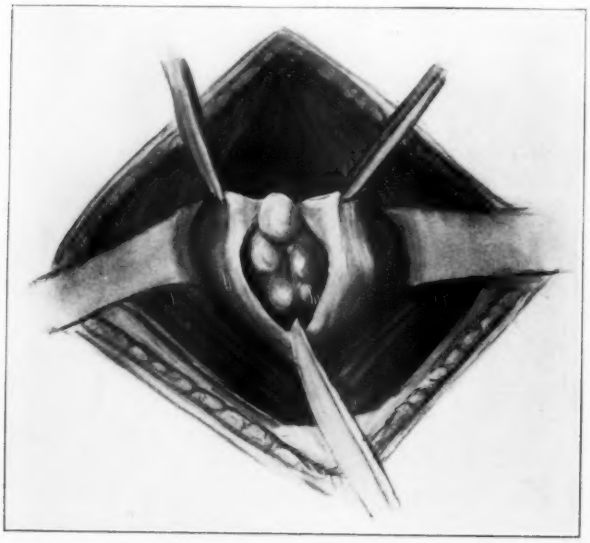

Fig. 7.—Modified from Veau. The capsule of the thymus has been seized and opened. The gland tends to herniate through this opening.

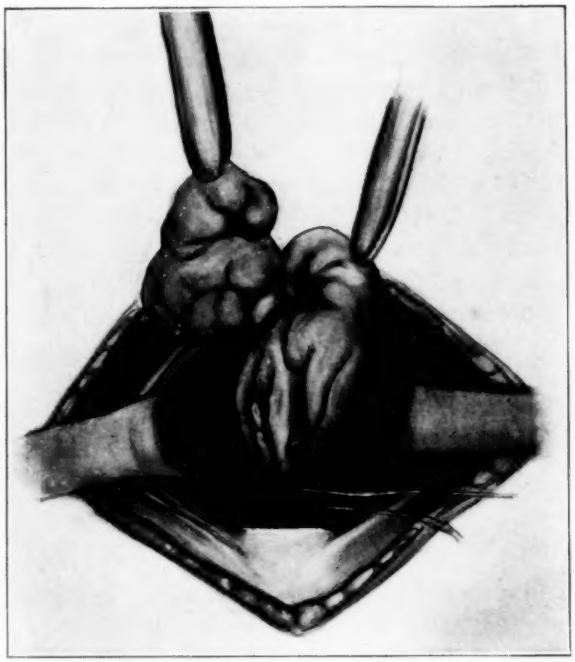

Fig. 8.—Modified from Veau. The gland has been pulled out of its sheath and a ligature applied about its base near the sternoclavicular articulation.

Fig. 9.—Photograph of patient taken Oct. 31, 1911, five months after the operation.

years of life, when its weight varies, according to different authors, from 6 to 15 grams, 2 to 7 grams being the average at birth. At puberty it begins to diminish in size, and is usually very small and more or less completely degenerated by the twenty-fifth year. Friedleben[3] states that it reaches complete development at birth, remains in this condition with some increase in size until the second year, and then gradually atrophies, the retrograde process being well advanced at puberty. Important exceptions to this course of growth at times occur. It is a ductless gland of a grayish-red color. In the new-born the gland extends from near the thyroid gland in the neck to the fourth costal cartilage below, lying directly behind the sternum and internal mammary arteries, whence it derives the

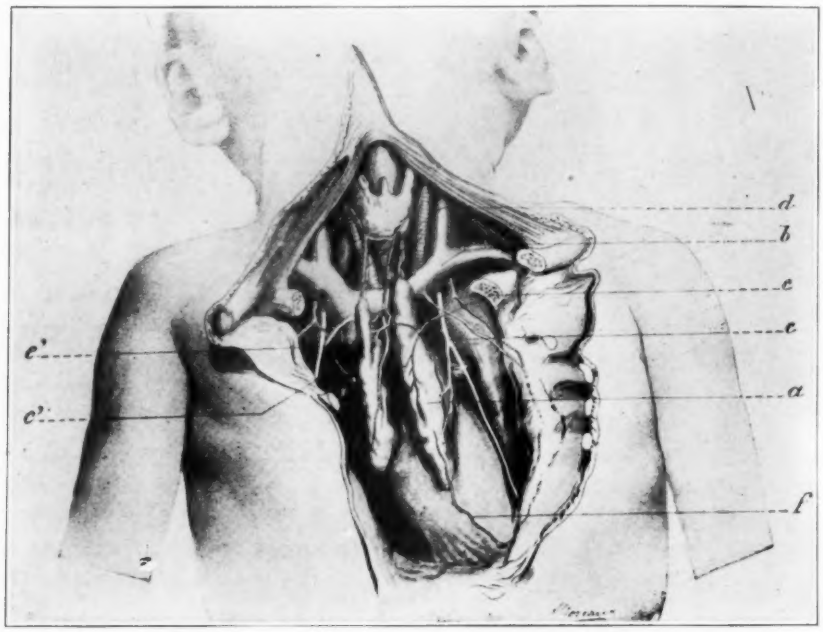


Fig. 10.—The thymus gland in a child one month old. From Olivier.

most of its blood-supply, and in front of the pericardium, large vessels and trachea. Laterally it is bordered by the two pleurae between which it lies. It is composed of two lobes, the right and left, lying together and rarely separated in the median line, being united by a thin tissue. The upper extremities, or poles, lie in the loose tissue immediately in front of the trachea, just above the sternal notch, and resemble two cords of fat 2 to 3 mm. in diameter, lying side by side and extending upward toward the thyroid isthmus. They move up and down with the respiration and

3. Friedleben, Die Physiologie d. Thymusdrüse in Gesundheit und Krankheit, 1858.

are the important parts to recognize in the operation for their removal. The gland is contained within its proper capsule. to which it is very loosely attached, allowing its easy removal in the living subject. The capsule itself is closely united with the surrounding structures. Its removal is not surgically feasible.

Besides the internal mammary artery, the superior and inferior thyroid arteries supply it with blood, the latter going principally to the upper poles. A pericardiac branch and possibly a phrenic branch reach it from below. The veins empty into the internal mammary, the innominate and the thyroid veins. The lymphatics go to the anterior mediastinal glands, and by some are said to terminate directly in the internal jugular vein. The nerves are said to be from the vagus and the sympathetic, though Olivier gives only a branch from the left phrenic. Histologically, the gland is composed principally of lymphoid tissue, within which are groups of cells, the corpuscles of Hassall, referring by their epithelial structure to the seat of their embryonic origin.[4] (Fig. 10.)

## PHYSIOLOGY

The function of the gland is none too well understood, although the recent extensive researches of Klose and Vogt, to be referred to later, furnish very strong evidence of its particular physiologic function and the absolute necessity of this function to normal development. Its occurrence throughout all the vertebrates and its maximum development and comparative large size during the early period of development naturally suggest some important relation to the phenomenon of the growth in this large division of the animal kingdom. That this function or relation is lost or is absent very soon after birth, at least in the higher animals, is well attested by numerous experiments on lower animals, as well as by several observations on infants from which it has been removed surgically for local disturbances of respiration. Possibly it is especially important during intra-uterine development before respiratory and alimentary functions have been established. Complete absence of the gland in infancy has been observed without serious disturbance of the health being attributed to this cause. However, it is difficult to be sure that some aberrant portion of the gland may not be present elsewhere and carry on its functions.

Friedleben (published in 1858) removed the thymus from twenty dogs and three goats, and observed very little influence on the general health of the animals operated on, although his technic for complete removal was not entirely free from criticism. His results refuted those

4. Biedl says that while it appears like a lymph-node, Stoehr and others consider these lymphoid cells as transformed epithelial elements and that it should no longer be considered a lymphoid structure or the site of origin of leukocytes, as held by some.

of Restelli in 1845 (the first one to remove the gland experimentally), the dogs, sheep and calves on which he operated all having died after a short period of fever. Friedleben did, however, among various changes observe in some cases increased flexibility, accompanied by slow growth of the bones. Thirty-five years later, in 1893, this line of investigation was resumed, and since that time many experiments have been made with observations and counterobservations offsetting each other about equally. However, with the constant improvement in technic and interpretation, certain negative and positive findings have been and are still being gradually evolved from the records of many experiments and observations. In 1898, Calzolari, quoted by Biedl, observed that removal of the testicles in rabbits led to increase in size of the thymus. Henderson, in 1904, quoted by the same author, reported that in a large number of cattle observed, castration produced a continued growth of the thymus and delay in its atrophy. Paton, quoted by Biedl, observed no enlargement if the thymus was removed before puberty.

U. Soli, quoted by Biedl in 1907, reported the thymus of capons to be more than double the size of the gland in non-castrated fowls, though removal of the thymus led to a lessening of testicular weight in his experience. The later experiments, quoted by Biedl, Basch (1903-1908) and Ranzi and Tandler (1909), bring out some positive phases that at present appear quite convincing. These investigators removed the thymus completely by splitting the sternum of dogs, as they believed it was not always completely removed by other experimenters. Basch removed the gland from twenty suckling puppies, seventeen of which he followed with controls. Most of these animals died in two months after the operation. In the second or third week after operation it was noticed that the bones were more easily bent than those of the controls, that the dogs spread their legs out more and were more unsteady in their gait. The posterior part of the body was smaller and the hind legs turned out more than normal. The dogs were less lively. Later the fore legs became more bent and weaker and the feet came down flatter than normal. There was a general lack of growth. It took less force to break leg bones in the operated animals. In fifteen to seventeen days the callus was larger in the controls. The difference could also be observed in the *x*-ray. The difference was most noticeable when the fracture occurred three to four weeks after extirpation. The bones were smaller and weaker. Microscopically, there was evidence of delayed ossification, not a rachitic type, but a general disturbance of bone development, especially in the lime content, which was lessened. He believes this may be the ground for rachitic changes. Double the normal quantity of lime was excreted from the animals. Svelha found that injection of extracts of thymus into dogs produced a fall of blood-pressure and acceleration of the pulse, the ani-

mals ultimately dying with symptoms of suffocation, but other observers have not obtained these results, and it is well known that extracts of many organs cause a fall in blood-pressure. Biedl does not believe in hyperthymism as a cause of death, and, in conclusion, says: "The pathologic relation of the thymus to *mors thymica* is not cleared up, nor is its relation to so-called status lymphaticus."

The work of Klose and Vogt,[5] previously referred to, is the most conclusive yet published on this subject and merits especial consideration. These authors observed that the thymus in dog increases in size until the fourteenth day and then rapidly degenerates. They believed the thymectomy should be done between the tenth and twentieth days after birth. Most of theirs were done the tenth day. Complete removal was absolutely necessary, as a small portion of the gland allowed to remain quickly reproduced itself and carried on its function. (In the case reported by the author, in which the larger parts of both lobes were removed, an examination by Dr. Joseph L. Miller over a year later showed an area of dulness corresponding to the gland fully as large as the normal area in a child of the age at which this one was examined.) The sternum of the animals had to be split to allow a complete removal of the gland. They studied fifty-four dogs operated on in this manner. Each dog had a control from the same litter. All the thymectomized dogs passed through four well-defined stages before succumbing to invariably fatal effects of the operation. In the first, or latent stage, the dogs resemble the controls, but on account of ravenous appetites and indiscriminate eating, they soon pass into the second, or adipose stage, in which they may be even heavier than their controls. These stages last two to three months or possibly longer. Their general appearance, even at this time, is one of physical weakness or flabbiness of the tissues, with definite mental apathy. Then follows the cachectic stage, in which they rapidly degenerate and become veritable runts. They become clumsy and stupid and walk with wide-spread legs, frequently falling. The condition well befits the name *"idiota thymica."* Coma follows this—*"coma thymica"*—in which the animals may lie several days before death supervenes. The life of these animals varies from three to seventeen months. The bones are smaller than normal and contain about one-half the normal percentage of lime salts. Taking this with the diminished size of the skeleton, the total lime content is only about one-fourth that of a normal skeleton. Summed up, the bones show the changes of osteoporosis, osteomalacia and rachitis. Their theory is that these changes are due to the

5. Klose and Vogt: Klinik and Biologie der Thymusdrüse, Beitr. z. klin. Chir., 1910, lxix, 1-200; Klose: Arch. f. Kinderh., 1910, lv. The first article gives a very complete bibliography of the clinical and biological literature with special reference to its surgical and neurological relations. The second article gives a very complete bibliography of the literature relating to pediatrics.

action on the bones of an unneutralized excess of nucleinic acid consequent on the absent detoxicating action of the thymus. They believe the lymphocytes bring the nucleins to the thymus rather than that the thymus is the origin of the lymphocytes. In short, a form of acid intoxication diminishing the deposition of lime salts in the bones or dissolving out some already deposited and at the same time causing edema of the brain and other tissues, in accordance with the theory of Martin Fisher, producing profound disturbances of the nervous system and various organs, accounts for the whole clinical picture.

The function of the thymus in older animals is probably taken up by the thyroid gland, spleen, pancreas and possibly other organs. It cannot be wholly removed surgically in man, and some thymus tissue is said to be present in every normal human thyroid.

It is suggested that destruction of its elements by faults of development or disease, or disturbance of its function in hypertrophy may produce in man metabolic changes proportionate in extent and character to the amount of interference with the normal physiology of the gland.

Thymus feeding is not efficient where there is deficient thymus function, as the ingested material does not have the detoxicating action of the normally functionating gland. The ingested gland contains but the metabolic products of its former activity which are really toxic in their action. Transplantation of thymus from other species of animals has not been effective as the tissue is soon destroyed or absorbed; but the transplantation from the same species into the peritoneum or spleen has been suggested by Klose and Vogt as worthy of the further investigation they intend to give it. The use of alkalies to overcome the supposed excess of nucleinic acid they claim should also be carefully studied. Several cases of *idiota thymica* in children are reported and illustrated in a recent volume of the Neue Deutsche Chirurgie,* devoted entirely to the surgery of the thymus. No definite plan of therapy is suggested in the text and the prognosis is discouraging. Thyroid feeding was useless.

### PATHOLOGY

The rôle of the thymus in causing disturbances of respiration is mentioned in the literature of the seventeenth, eighteenth and ninteenth centuries, but the beginning of our more definite knowledge of the gland dates from Kopp's description of "thymic asthma" in the years 1829 and 1830. He believed it was a mechanical or compression disturbance exercised by the gland on the trachea. Friedleben, in 1858, denied the existence of "thymic asthma." Renewed interest in the gland was awakened by Grawitz's[6] article in 1888, on cases of sudden death in babies. He

* Klose, Heinrich: Chirurgie der Thymusdrüse, Neue Deutsche Chirurgie, 1912, iii.

6. Grawitz, P., Griefswald: Ueber plötzliche Todesfälle im Säuglingsalter, Deutsch med. Wchnschr., Leipzig and Berlin, May 31, 1888, No. 22, 429.

mentions two cases of sudden death from suffocation in previously healthy children and considers the importance of the subject from the medico-legal standpoint. The first case was that of an 8-months-old child that came to his notice four years before writing his article, when he was in Berlin. The child, which had previously been healthy, was found dead in its own bed one morning with the feather coverlet over its face, and the nurse, whose bed was next to the child, was blamed for neglect and brought before the court for punishment. An autopsy showed the only pathologic condition to be a greatly enlarged thymus which the author believed to be the direct cause of death by suffocation, as further evidence showed that the covering of the child's head as on the night of its death was not an unusual occurrence. The nurse was freed, but more on account of lack of proof of guilt than the judge's agreement with his professional opinion. After that he was on the lookout for a similar case and it was not until four years later, shortly before he published his article, that he met his second one. This was a 6-months-old child that had been in apparently perfect health. The father had been holding the child in his arms, showing it off to his friends when it suddenly had an attack of suffocation, became cyanotic and quickly died. The autopsy showed some rachitic changes at the chondrocostal junction and a greatly enlarged thymus that extended from the thyroid over the front of the pericardium and measured 7.5 cm. long by 6 cm. wide and 1.5 cm. thick, although the latter figure was somewhat uncertain on account of its shape. The antero-posterior diameter of the thoracic outlet at the upper part of the manubrium measured 1.8 cm. Diagnosis, suffocation from hyperplasia of the thymus. As his experience was in direct contrast to that of Friedleben's teaching that "enlargement of the thymus is not to be considered as a cause of sudden death," he believed his two cases "go to fill a certain place in legal medicine previously left vacant."

In 1614 F. Plater recorded the death of a child 5 months old that had died suddenly from respiratory obstruction. Two sons had previously died in a similar manner. Plater found at autopsy an enlarged thymus. Morgagni, in 1762, reported a similar case.

Hedinger, quoted from Zesas,[7] reported eighteen cases of thymus death in the new-born from flattening of the trachea by pressure of the thymus on the innominate artery. The children died from suffocation. Serious circulatory disturbances have been reported by pressure on the pulmonary artery and the superior vena cava. Farret mentions that abnormally the vena cava may lie between the gland and the sternum. Pressure on the trachea direct and interference with swallowing have occurred. Pressure on the vagi and left recurrens may possibly cause spasm of the glottis and disturbance of the heart.

7. Zesas: Deutsch. Gesellsch. f. Chir., May, 1910, p. 125.

In the years 1889 to 1891, soon after the appearance of Grawitz's paper, Arnold Paltauf[8] formulated his well-known hypothesis which soon became quite generally accepted. In his opinion it was not proved that "thymus death" was ever due to pressure of the enlarged thymus on the trachea, blood-vessels, or nerves; and he attributed it to the patient's having a peculiar "lymphatico-chlorotic" constitution, which he called "Status lymphaticus."

This rather uncertain nosological entity is described as a "condition of bodily debility which is characterized by hyperplasia of the thymus and of the lymphoid tissues generally throughout the body; and also, especially in adult cases, by hypoplasia of the heart and of the arterial system. It is accompanied by a great lowering of the patient's power of resistance, and is believed to account for a large number of otherwise unexplained causes of sudden death." He believed the enlarged thymus to be but one of the manifestations along with the general increase of lymphoid tissue elsewhere. In all cases the thymus is said to be above normal in size and often the enlargement is very great. The enlargement is a general hyperplasia of the lymphoid elements.

Escherich suggested that the symptoms were due to a hyperthymization of the blood. The sudden death of Professor Langerhans' boy after a prophylactic dose of antidiphtheritic serum was attributed at the time to this condition.

Death in or following narcosis has frequently been shown to occur in persons with a persistent thymus, the death supposed to be due to some irritation of an abnormally susceptible heart. Deaths from cocain poisoning have been considered in the same category. Audebert and Lenormant, quoted from Zesas, report from literature forty cases of narcosis death in which a more or less enlarged or persistent thymus was present—20 to 25 gms. Twenty-nine were under 20 years of age. The following anesthetics were blamed for the deaths.

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|---|---|---|---|
| Chloroform | 22 | Laughing gas | 1 |
| Ether | 7 | Ethyl Chlorid | 1 |
| Billroth's mixture | 5 | | |

Two patients had previously taken chloroform safely.

Besides the conditions in which enlargements or persistence of the gland play the principal rôle, the gland is subject to various other pathologic changes such as might be expected to occur in an organ of its dual origin. Its vascular changes are similar to those occurring in other organs. Acute pyogenic affections with abscess and sudden death have been reported. Syphilitic and tuberculous infections also occur. Lym-

8. Paltauf, A.: Wien. klin. Wchnschr., 1889, No. 46; 1890, No. 9.

phoid infiltration with enlargement may take place in leukemia and pseudoleukemia. Primary tumors, both mesoplastic and epiblastic, develop from its tissues, lymphosarcoma being the more frequent representative from the former, and dermoid cysts and carcinoma the more frequent from the latter elements.

Portions of the thymus may be inclosed within the thyroid and give rise to tumors, the *"epitheliome thymique intrathyroidien,"* of Achard and Paisseau.

### THE THYMUS IN GRAVES' DISEASE

Astley Cooper first directed attention to the persistence or hyperplasia of the gland in association with Graves' disease. Bonnet, quoted by Zesas, reported twenty-eight cases of persistent thymus with Graves' disease, six of which ended in sudden death. The persistent thymus was considered to be in direct relation to the death in four of these.

Hauseman, in 1905, reported four cases of persistent thymus in eight autopsies on Graves' disease subjects. Thorbecke, quoted by Zesas, in thirty-five cases of Graves' disease, found twenty-one with persistent thymus or hyperplasia. Twelve of these died of heart paralysis shortly after the operation (ligature, strumectomy and excision), and two during the operation. The weight of the thymus varied from 250 gm. to 690 gm. Capelle (Zesas), in sixty reported autopsies on cases of Graves' disease, found 79 per cent. had enlarged thymi. Of twenty-two operative deaths, twenty-one, or 95 per cent., had enlarged thymi. In Allbutt's second edition, Hector McKenzie says, "The thymus was enlarged in all fatal cases of Graves' disease observed by the author that came to autopsy," and he suggests that "possibly every case in which there is a thymus persisting into adult life is one of potential or latent Graves' disease."

Gebele,[9] of München, in an elaborate article, reports his observations on and conclusions derived from a series of experiments made to determine the interrelation of the thymus and thyroid glands. At the beginning he states: "Status lymphaticus is relatively frequent with Basedow's disease and is considered to-day as the most common cause of death in this disease." He experimented with forty-nine dogs 4 to 8 weeks old, and four kittens 3 to 4 weeks old. The experiments included feeding with sheep's thyroid both before and after extirpation and implantation of thyroid and thymus, thyroid implantations in bone, spleen, abdominal and thoracic walls, thymus implantations in the abdominal wall, and two cases of implantation of human goiter material from cases of Graves' disease. Total extirpation of the thymus led to results similar to those reported by Basch. He believes that the thymus plays a detoxicating rôle and that its increase in Graves' disease is com-

9. Gebele: Ueber the Thymus persistens beim Morbus Basedowii; Klinisch-experimentelle Studie, Beitr. z. klin. Chir., Tübingen, 1910, lxx, 20.

pensatory and the death a heart death from the thyroid secretion. He further states that when enlargement of the thymus is present operation on the thyroid should not be attempted as it shows a late stage of the goiter, and death is likely to ensue, not as a result of the enlarged thymus, but as a result of heart weakness.

Zesas, in 1910, suggested removal of the thymus with the thyroid in severe cases of Graves' disease with enlarged thymus, but at that time knew of no such attempts having been made. In June, 1910, a removal of the thymus was done by Garré in the case of Capelle and Bayer,[10] to be referred to later, with much improvement of the general condition, although removal of a portion of the thyroid became necessary later. These authors believe that the thymus unfavorably affects the course of Graves' disease, and that it has an independent action separate from the hyperplasia of the lymphatic system. It adds the depressing effect of its secretion on the action of the heart. They quote Svelha's observations, previously mentioned, on the influence of the thymus secretion in lowering blood-pressure and diminishing heart-action. They believe "the greater the size of the thymus the greater the danger from Graves' disease." They believe the improvement with return to normal of the previously typical struma blood-findings six weeks after thymectomy supports their contention. This is the first reported case of thymectomy in this condition so that from the practical standpoint we have much yet to learn of the interrelation of these organs in diseased conditions.

As stated in the introduction, the surgery of the thymus gland up to the present time has been almost entirely limited to its operative removal —thymectomy—for the relief of urgent symptoms of tracheal or esophageal obstruction.

A careful study of these symptoms is therefore necessary to determine their origin, as other factors than the thymus may be responsible for them. It seems advisable, however, to take up the operative measures first and the indications for operation later on.

### OPERATIVE TREATMENT. THYMECTOMY

The accumulating evidence against the thymus as a mechanical agent in causing severe respiratory distress and sudden death led to the first operative treatment of the gland in man by Rehn, in 1896. König also reported an operation on the gland the same year, and Purrüker an operation in 1899. In the sixteen years since these pioneers first ventured into this new domain of operative surgery, something over fifty operations for removal of the thymus have now been performed. A study of these cases lays a good foundation for operative technic and furnishes a modest

10. Capelle and Bayer, Bonn: Thymektomie bei Morbus Basedowii. Beitr. z. klin. Chir., Tübingen, 1911, lxxii, 214.

basis for determining indications for operation. The immediate results of the operation have also been determined; the remote results are yet to be learned. Three types of operation have been performed, exothymopexy, resection of the manubrium and thymectomy.

Exothymopexy was the operation performed by Rehn and consisted in elevating the thymus out of the thorax and fastening it to the tissues of the neck or top of the sternum, as he feared the consequences of a complete removal of the gland. In a later case Rehn removed a small portion of the gland prior to its fixation, as did also König in his first case. Three cases have been treated in this manner with no fatalities.

### RESECTION OF THE MANUBRIUM

This has never been practiced alone, but always in connection with other measures, as exothymopexy or partial thymectomy. Three operations of this type have been reported by König, Morse-Murphy and D'Oelsnitz and Pratt, respectively. Two of these patients died, one of mediastinitis. Schwinn split the manubrium in one case as an accessory measure to a thymectomy. The patient recovered.

### THYMECTOMY

This is practically the only operation performed now. The gland is enucleated from within its capsule. Owing to the normal fixation of certain parts of the gland within the capsule the entire gland is probably never removed. On account of these conditions, the French authors, to whom we are greatly indebted for much of our knowledge in this branch of surgery, designate the operation as *"thymectomie subtotale sous-capsulaire."*

### ANESTHETIC TO BE USED

This is an especially interesting problem when we consider that deaths from anesthesia are so frequently attributed to the influence of the thymus on which we are now contemplating operating. Veau and Olivier, in their work, used chloroform in most of their cases. In thirteen cases chloroform is mentioned as the anesthetic, and in five ether was given. Chloroform and ether were given once. Thus a general anesthetic was used in at least nineteen, or about two-fifths of the cases, and in none of them was there any evidence that it influenced unfavorably the course of the operation. It was not used in some cases in which the condition of the child was such that an anesthetic was contra-indicated on general principles. Ether will naturally be the anesthetic of choice to American surgeons, although Jackson and Schwinn, in this country, both operated under chloroform anesthesia. Cocain has been advocated by some, but there is no record of its employment, and its uncertain action makes it a particularly dangerous drug to use in children.

### TECHNIC OF OPERATION

The plan of operation is that worked out by Veau and presented with illustrations by Veau and Olivier.[11] Several of the cuts accompanying this article are modified from those of Veau. An incision 4 to 5 cm. long is made in the middle line of the neck with its lower end terminating just below the upper border of the sternum and extending down to the deep fascia (Fig. 4). The sternal portions of the sternomastoid muscles appear in the field. An incision of the deep cervical fascia now exposes the sternothyroid muscles, which are separated by blunt dissection. This exposes the pretracheal tissues and in the lower part of the wound can be seen rising and falling with each respiration, the upper portion of the thymus resembling very closely in color and structure the omentum seen through a thin hernial sac (Figs. 5, 6, 7).

The gland when first seen is usually inside its capsule, which must be lifted up with dissecting forceps and incised. Further resembling the omentum, the gland now shows a tendency to herniate through the capsule at each expiration when it is seized with forceps and gradually withdrawn from its investing sheath until the larger portion is extrathoracic, when it may be tied off at its more fixed portion near the sternoclavicular junction where it is joined by the nutritive branches of the internal mammary arteries (Fig. 8). Veau believes this precaution against hemorrhage unnecessary, as it is sometimes impossible to apply a ligature on account of rupture of the gland during removal, these cases having done just as well as others in which the ligature was applied. Some have used blunt instruments for separating the gland from its capsule when it did not herniate readily. At times one lobe may be removed in its entirety before the other is accessible, or both lobes may come out together. Such was the case in my single experience. The wound is closed with deep stitches of catgut in the cervical structures and the skin with silk or horsehair. The vertical skin incision has been employed by nearly all operators. Buford reports two cases in which he used a low curved transverse incision, and Chas. Mayo reports one case in which the transverse incision was used. Garré used it once in operating on an adult.

As the gland lies in front of all the important structures in the neck and thorax, the trachea, innominate artery and veins, as well as the heart and pericardium, these deeper structures are not interfered with in the enucleation, and, indeed, usually are not seen. The intrathoracic pressure and the viscosity of the tissues thus enable the surgeon to accomplish with ease and comparative safety in the living child what is difficult or impossible through a similar incision in the cadaver. The pleurae are in no way interfered with, as they are attached to the capsule of the gland which is carefully and easily left, except at the point of the original incision

11. Veau and Olivier: Presse méd., 1910, xviii, 257.

for liberation of the contents. A little study of the upper poles of the gland in the infant cadaver will familiarize one with their appearance and relations, although, as I have said, it is only in the living child that one can appreciate the real condition with which one has to deal and the facility with which the enucleation can be carried out. It is certainly very much easier and simpler than a thyroidectomy. The tissue removed has almost invariably been normal thymus with simple hyperplasia, although Veau has several times removed broken down lymph-glands as incidents of the operation. In fifteen cases in which the weight removed was mentioned, it varied from 2 gm. to 21.5 gm., with an average of 8.6 gm. The real efficacy of the operation, however, does not always depend on the total amount of gland removed, for the removal of a small portion directly concerned in producing symptoms of obstruction has produced quite as striking relief as the removal of considerably larger portions less directly concerned in the compression. The youngest child operated on was 23 days old, and the oldest, with the exception of a single adult, 5 years; the average age being about 14 months. One-half of the patients of whom the age was given was under 12 months.

The *x*-ray has been used with apparently good results, particularly where the constitutional symptoms were the more urgent, but it is not to be recommended in place of the so generally successful operative measures in the cases imminently threatening death by suffocation.

### OPERATION IN THE ADULT

In the adult case, a woman 22 years old, reported by Capelle and Bayer, and operated on by Garré, the patient was suffering from Graves' disease. A curved incision was made across the lower part of the neck, exposing the thyroid, and lower down the thymus. The capsule of the thymus was opened and the gland bulged out. It was seized with the forceps and several portions removed. A suspected pleural injury caused the operator to desist and the wound was closed and prompt healing followed. The thymus removed weighed 15 gm. All symptoms improved and the blood picture returned to normal in six weeks. Several months later the symptoms increased again and the right lobe of the thyroid was removed.

This is the only case of thymectomy in the adult I was able to find. It appears that the same tendency for the enlarged gland to herniate obtains here as it does in the infant. He mentions, however, his fear of pleural injury. Possibly the extra organic respiratory sounds frequently heard in the empty space after removal of the thymus or thyroid were heard in this case. If the indications suggest the necessity of removal of the hypertrophied thymus in the adult it appears from Garré's experience to be entirely feasible.

### INDICATIONS FOR OPERATION

Olivier,[12] in his recent work on the surgery of the thymus, which is the most complete exposition of the subject yet published, groups the clinical symptoms of hypertrophy demanding surgical interference in two general classes. In the first class are included all cases characterized by permanent dyspnea. This he terms the continuous form. In the second class he includes those cases characterized by irregular suffocative attacks while free from dyspnea in the intervals. This he terms the intermittent or discontinuous form. Several clinical varieties are included in these two general types, and occasionally aberrant forms occur.

### THE CONTINUOUS FORM

This form is generally seen in very young infants—4 to 6 months—that have had difficult respiration since birth or shortly after. This difficulty gradually increases until the child has a suffocative attack lasting ten to fifteen minutes, accompanied at first by rapid respiration and followed by complete apnea and cyanosis with eventual resumption of breathing and amelioration of distressing symptoms. A similar attack may occur the next day or even in a few hours. Between the suffocative attacks the dyspnea is continuous and there is commonly heard a distinct stridor day and night. This stridor is usually more intense on inspiration and may resemble a coarse moist râle. There is commonly present suprasternal retraction in connection with the dyspnea and both are increased by hyperextension of the head, the recumbent position or examining the throat with a tongue depressor. These symptoms should suggest an enlarged thymus and lead to a systematic examination of the patient.

Several observers have called attention to an arching forward of the manubrium sterni seen by them in several instances and believed to be due to the presence immediately behind of the enlarged gland. Rehn called attention to a soft tumor to be felt in the suprasternal space during expiration only. This is referred to as "Rehn's sign." Several observers claim to have seen and palpated such a tumor in their examinations, while a not inconsiderable number of equally careful diagnosticians have been unwilling to commit themselves on this point. It certainly is very difficult to determine just what is under the examining finger when the jugulum fills out in a strenuous expiratory effort in a dyspneic child.

Percussion may furnish definite evidence of hypertrophy of the thymus, but its value in children depends greatly on the skill of the examiner. According to Blumenreich the normal area of dulness is

12. Olivier: Anatomie topographique et chirurgie du thymus, G. Steinheil, Paris, 1911.

triangular, with its base above, corresponding with the sternoclavicular articulations and the apex below at the level of the second rib, the right border corresponding with the right border of the sternum and the left border 6 mm. to the left of the sternum. He further states that it is always separated from the heart dulness by a resonant area one or two fingers wide corresponding to the interposition of lung tissue. In hypertrophy this area passes the normal limits usually more to the left and is continuous with the heart area below without the interposed pulmonary resonance (Fig. 11). Boggs[13] noticed that the area of dulness varied in height with the flexed and extended neck, sometimes at the lower border as much as an interspace. This has since been called "Bogg's sign."

The *x*-ray is another diagnostic help. Hochsinger[14] used it in studying this condition in 1903. In fifty-eight infants under 2 years of age, each presented a distinct thymic shadow going from the manubrium to the heart shadow.

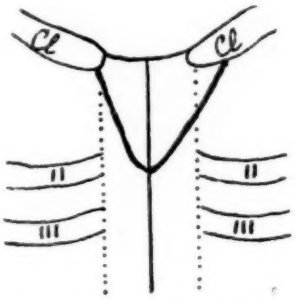


Fig. 11.—Percussion of the thymus after Friedjung-Blumenreich. Heavy line delimits normal thymus dulness.

Malavialle, quoted by Olivier, speaks of a mediastinal shadow extending either to the right or to the left—more frequently the left—beyond the vertebral shadow, and which is always continuous with that of the heart; sometimes blending with it so exactly as to render impossible the separation of the one from the other, and sometimes becoming directly continuous with the heart shadow without disturbing its regular form. While the lateral boundaries of the shadow are not very definite, an observation made by me before and after operating shows a difference of at least 2 cm. in the breadth of the shadow, it being that much narrower after the operation (Figs. 1 and 2).

Where the *x*-ray evidence is positive it is of real value in diagnosis, but when it is negative it is not to be considered as final. The specific gravity of the thymus gland is not much different from that of the blood

13. Boggs: Arch. Int. Med., Nov. 15, 1911.

14. Hochsinger: Stridor Congenitus und Thymus Hypertrophie (mit Röntgenbildern), lxxv Congres des naturalistes et medicines allemands, Cassel, September, 1903, ii, 247.

in the great veins and the aorta with whose shadows it must be blended and on whose shadows it must be superimposed. When extending beyond these and separating the lungs its shadows must then become unique and of distinct value.

Chevalier Jackson,[15] of Pittsburgh, first successfully used it as a diagnostic measure previous to operation in a case reported by him.

Jackson was also the first one to observe the tracheal stenosis by means of the bronchoscope in the same patient. Laryngoscopy seldom affords more than negative evidence owing to the inherent difficulties attending its use in young children. Intubation has several times led to the diagnosis of hypertrophy of the thymus; in fact, it has been the previous treatment in a number of cases that have later come to operation. The first reported operative case by Rehn, in 1896, had had a previous intubation without permanent relief, the long tube demonstrating the presence of an obstruction low down in the trachea.

Complete inability to swallow was observed by Flügge in an infant that showed a large thymus on section. Demmer reported orally a similar case that also came to section. Avellis mentioned two cases in which the stridor hindered the swallowing, and Hinrichs adds a case of a female child that soon after birth was observed to drink very slowly, requiring an hour to swallow a feeding. Several weeks later the constant regurgitation of food immediately after swallowing with an increasing respiratory distress led to an operation for removal of the thymus, with immediate improvement in breathing and entire relief of the dysphagia.

A negative diagnostic measure is the absence of all other causes for the existing condition.

Summarizing: The occurrence in a child of constant dyspnea with attacks of suffocation and a more or less continuous stridulous respiration and possibly a suprasternal tumor on expiration may well be considered diagnostic of an enlarged thymus.

The diagnosis being established, the operation in this type is imperative. Death has occurred in the first suffocative attacks as in the two original cases reported by Grawitz. It may occur in any subsequent attack or after longer or shorter periods of dyspnea. The dyspnea has a tendency to augment and the suffocative attacks to increase in number and severity so that such a child is at all times in imminent danger of sudden death.

Four of the operative cases were complicated by the presence of enlarged and necrotic tracheobronchial lymph-nodes. Three were in the practice of Veau and one in that of D'Oelsnitz. Portions of the thymus were removed along with necrotic lymph-nodes. Although these four were thymus operations the enlarged tracheobronchial glands were con-

15. Jackson, C.: Jour. Am. Med. Assn., May 25, 1907.

sidered responsible for the symptoms. All four of these patients died sooner or later from shock, local infections and general tuberculosis. Olivier offers the following suggestions for making a differential diagnosis to guard against operation in a condition fraught with such a high operative mortality.

There is in almost all of these cases a history of a previous pulmonary infection and the dyspnea is of later origin instead of being congenital, or of very early appearance as in the typical condition. The stridor is also acquired and is predominately of the expiratory type. The percussion note may give no abnormal range of dulness in purely tracheobronchial adenopathy. The *x*-ray also gives a different picture, the shadow when broadened being lower down and often to the right.

Three other varieties of the continuous form are mentioned. They are the *"forme dysphagique," "forme stridoreuse"* and *"formes reduites."* To the first belongs the case of Hinrichs, previously mentioned, of the child that from birth experienced great difficulty in swallowing and was entirely relieved by thymectomy. The *"forme stridoreuse"* refers rather to an epiphenomenon than to a separate form in which stridor is an accompanying symptom. Thymectomy for stridor alone should never be done, as it may easily be due to other causes than an enlarged thymus, and its presence without dyspnea and suffocative attacks is not an indication for the operation. Under the term *"formes reduites"* are considered two cases with dyspnea and stridor, but without suffocative attacks. As permanent dyspnea is an indication in itself, and the first suffocative attack may be fatal, an operation should be performed in these cases, provided no other cause than the enlarged thymus is found to account for the symptoms.

### THE INTERMITTENT FORM

Under this heading Olivier includes six cases. The personal one described by the author belongs to this type as does one of Buford's cases. These would increase the number to eight. These children are usually older than those in the other main group, their ages being 4, 4, 7, 10, 10, 11, 12 and 12 months, respectively. They are generally quite normal during their earlier months, or at least have not shown evidence of respiratory troubles. Suddenly without warning they have a suffocative attack with cyanosis, jerking of the limbs and absolute apnea, followed by gradual resumption of breathing and return after four or five minutes to normal with neither dyspnea nor cyanosis. It may be several months before a recurrence of the attack. The attacks may eventually become much more frequent and even several a day. The children are usually well nourished. A fit of anger or fear or crying will bring on an attack. The physical signs of an enlarged thymus, the increased dulness, the suprasternal bulging with the appearance of a palpable tumor—Rehn's

| No. | Name of Observer | Date of Operation | Reference | Age | Résumé of Symptoms and Pathology | Type of Disorder |
|---|---|---|---|---|---|---|
| 1 | Rehn | April 16, 1896. | Berlin. klin. Wchnschr., Oct. 5, 1896, p. 887. Article by Siegel. | 2½ years | Constant dyspnea with inspiratory stridor and suffocative attacks. | Continuous |
| 2 | König | Not given. Probably 1896. | Centralbl. f. Chir., 1896, No. 21, p. 605. | 9 weeks | Constant dyspnea, stridor and suffocative attacks; mass felt in jugulum. | Continuous |
| 3 | Purrücker | Not given. Probably 1899. | Med. Gesellsch. z. Magdeburg, May 18, 1899. | 2½ years | Constant dyspnea, stridor and suffocative attacks. | Continuous |
| 4 | Ehrhardt | Sept., 1905. | Archiv. f. klin. Chir., 1906, lxxviii, 599. | 2 years | Constant dyspnea with suffocative attacks and stridor, noncongenital. Trachea definitely flattened from before backward. | Continuous |
| 5 | Rehn | Not given. Probably 1906. | Archiv. f. klin. Chir., 1906, lxxx, 468. | 4 months | Constant dyspnea with suffocative attacks and stridor. | Continuous |
| 6 | König | Not given. Probably 1906. | Verhandl. d. Deutsch. Gesellsch., 1906, p. 692. | 7 months | Constant dyspnea with stridor. | Continuous |
| 7 | Jackson | Oct. 2, 1906. | Jour. Am. Med. Assn., May 25, 1907, p. 825. | 4 years | Constant dyspnea with stridor. Compressed trachea seen through bronchoscope. | Continuous |
| 8 | Hinrichs-Alsberg | Dec. 5, 1906. | Berlin. klin. Wchnschr., April 27, 1908, p. 825. | 10 months | Constant dyspnea with stridor and dysphagia. | Continuous |
| 9 | Enderlen | Not given. Probably 1906. | Deutsch. med. Wchnschr., 1906, p. 1976. Reported by Kaufman. | 3 years | Constant dyspnea with suffocative attacks. | Continuous. Due to abscess from spondylitis |
| 10 | Nicoll | Not given. Probably several years previous to 1908. | Glasgow Med. Jour., 1908, lxx, 107. Article by MacLennan. | ..... | Cough and dyspnea. | Continuous |
| 11 | Schwinn | March 29, 1908. | Jour. Am. Med. Assn., June 20, 1908, 2059. | 23 days | Constant dyspnea with stridor and suffocative attacks. Enlarged thyroid. | Continuous |
| 12 | MacLennan | Not given. Probably 1908. | Glasgow Med. Jour. 1908, lxx, 107. | ..... | Stridor. | Continuous ? |
| 13 | | | | | | |
| 14 | | | | | | |
| 15 | MacLennan | Not given. | Reported by Olivier in Anatomie topographique et chirurgie du thymus, Paris, 1911. | ..... | Hypertrophy of the thymus. | Continuous ? |
| 16 | | | | | | |
| 17 | | | | | | |
| 18 | Rammstedt | Not given. Probably 1908. | Reported by Klose; Arch. f. Kinderh., lv, Parts 1 and 2. | 10 months | Constant dyspnea with suffocative attacks and convulsions. | Continuous |

WITH IMMEDIATE AND REMOTE RESULTS. FROM 1896 TO APRIL, 1912

| Type of Operation | Anesthetic | Amount of Gland Removed, gms. | Result of Operation on Permanent dyspnea. | Result of Operation on Suffocative Attacks | Result of Operation on Stridor. | General Results and Autopsy Findings |
|---|---|---|---|---|---|---|
| Exothymopexy after tracheotomy. | ..... | ..... | Immediate and complete relief | Immediate and complete relief. | ..... | Good recovery. |
| Tracheotomy, partial thymectomy, exothymopexy. | ..... | ..... | Relief complete in 1 month. | Immediate and complete relief. | ..... | Good recovery in one month. Suffered from rickets for 2 or 3 years. Health good 9 years later. |
| Thymectomy, intracapsular. | ..... | ..... | Immediate and complete relief | Immediate and complete relief. | Immediate and complete relief. | Recovery. |
| Thymectomy, intracapsular. | ..... | ..... | Immediate and complete relief | Immediate and complete relief. | Complete relief later. | Recovery. |
| Thymectomy, Exothymopexy | ..... | ..... | Immediate and complete relief | Immediate and complete relief. | Appeared when child cried. | Recovery. |
| Tracheotomy. Thymectomy with removal portion manubrium sterni. | ..... | ..... | Improved. | ..... | Improved. | Improvement. |
| Tracheotomy. Thymectomy, intracapsular. | Chloroform | ..... | Eventual complete relief. | ..... | Complete relief. | Recovery after slow convalescence. |
| Thymectomy, intracapsular. | ..... | 6 | Immediate and complete relief. | ..... | Immediate and complete relief. | Recovery. Immediate and complete relief of dysphagia. |
| Tracheotomy. Thymectomy. | ..... | ..... | Immediate and complete relief. | Immediate and complete relief. | ..... | Death from bronchitis 1 week later. Autopsy: Compression of the trachea by a tubercular abscess from cervical spondylitis. |
| Thymectomy. | ..... | ..... | Immediate relief. | ..... | ..... | Recovery. Condition good two years later. |
| Thymectomy. Section of sternum. Thyroidectomy. | Chloroform | ..... | Immediate and complete relief. | Immediate and complete relief. | Immediate and complete relief. | Recovery. |
| Thymectomy. | ..... | ..... | ..... | ..... | Progressive relief. | ..... |
| Thymectomy. | ..... | ..... | ..... | ..... | ..... | Three deaths from spasm of the glottis and progressive heart weakness. |
| Thymectomy. | Chloroform | ..... | Immediate and complete relief. | Immediate and complete relief. | ..... | Recovery. Condition good 2 years later. |

| No. | Name of Observer | Date of Operation | Reference | Age | Résumé of Symptoms and Pathology | Type of Disorder |
|---|---|---|---|---|---|---|
| 19 | Morse-Murphy | Not given. Probably 1908. | Arch. Pediat., August, 1908, p. 607, Article by Meyer. | 11 weeks | Constant dyspnea with stridor. | Continuous |
| 20 | Denecke | Aug. 7, 1908. | Deutsch. Ztschr. f. Chir., 1909, xcviii, 544. Résumé by Olivier, Anat. top. et chir. du thymus, Paris, 1911. | 5 years | Enlargement of veins at the base of the neck, stridor, tumefaction in jugulum, loss of consciousness with cyanosis. | Cyanotic form |
| 21 | Veau and Olivier | May 19, 1909. | Arch. méd. d. enf., 1909, p. 817. | 1 year | Suffocative attacks with stridor and spasm of the glottis. | Intermittent |
| 22 | Veau and Olivier | May 29, 1909. | Arch. méd. d. enf., 1909, p. 817. | 11 months | Constant dyspnea with stridor and suffocative attacks. | Continuous |
| 23 | Veau and Olivier | June 19, 1909. | Arch. méd. d. enf., 1909, p. 817. | 22 months | Suffocative attacks with spasm of the glottis. | Intermittent |
| 24 | D'Oelsnitz and Prat. | August, 1909. | Bull. Soc. de pédiat. de Paris, 1909, No. 7, 357. | 13 months | Suffocative attacks with constant dyspnea and stridor. | Continuous |
| 25 | D'Oelsnitz Prat and Boisseau | Nov., 1909. | Bull. Soc. de pédiat. de Paris, Mar. 15, 1910. | 4 years | Constant dyspnea with suffocative attacks. | Continuous |
| 26 | Vignard and Sargnon | Not given. Probably 1909. | Ann. de méd. et chir. enf. 1910, xiv, 632. | 4 months | Suffocative attacks, slight stridor and spasm of glottis. | Intermittent |
| 27 | Lexer, Tiling | Not given. Probably 1909. | Königsberg These, 1909. Reported by Olivier in Anat. top. et chir. du thymus, Paris, 1911. | 7 months | Constant dyspnea with stridor. | Continucus |
| 28 | Veau and Olivier | Feb. 1, 1910. Oct. 17, 1910. | Reported by Olivier in Anat. top. et chir. du thymus, Paris, 1911. | 4 mos., 1 yr. | Constant dyspnea with congenital stridor and suffocative attacks. | Continuous |
| 29 | Bircher | Not given. Probably 1910. | Schweiz. Rundsch. f. Med. April 9, 1910, No. 14. | 2 years | Constant dyspnea. | Continuous |
| 30 | Veau and Olivier | May 30, 1910. | Anat. top. et chir. du thymus, Olivier, Paris, 1911. | 7 weeks | Constant dyspnea, stridor and dysphagia. | Continuous |
| 31 | Tisserand | June 11, 1910. | Lyon chir. February, 1911, p. 145. | 1 year | Constant dyspnea and stridor. | Continuous |
| 32 | Capelle and Bayer Garré operator | June 26, 1910. | Beitr. z. klin. Chir., Tübingen, 1911, lxxii, p. 214. | 22 years | Graves' disease. | Associated with Graves' disease |

WITH IMMEDIATE AND REMOTE RESULTS. FROM 1896 TO APRIL, 1912—CONTINUED

| Type of Operation | Anesthetic | Amount of Gland Removed, gms. | Result of Operation on Permanent dyspnea. | Result of Operation on Suffocative Attacks | Result of Operation on Stridor. | General Results and Autopsy Findings |
|---|---|---|---|---|---|---|
| Exothymopexy with resection of manubrium sterni. | ..... | ..... | Improved. | ..... | ..... | Died 16 days after operation. |
| Thymectomy. | Chloroform-ether. | ..... | ..... | ..... | Progressive relief. | Gradual diminution of venous distention. |
| Thymectomy. | Chloroform | 2 | ..... | Immediate and complete relief. | Immediate and complete relief. | Recovery. |
| Thymectomy. | Chloroform | 4.55 | Immediate and complete relief. | Immediate and complete relief. | Gradual relief. | Recovery. Stridor practically gone 1 year later. |
| Thymectomy. | Chloroform | ..... | ..... | Gradual and final relief. | ..... | Complete relief 2 years later. |
| Thymectomy. | Chloroform | ..... | Complete relief in 10 days. | Immediate and complete relief. | Immediate and complete relief. | Recovery. Well 4 months later. |
| Thymectomy. Tracheotomy and resection of manubrium sterni. | ..... | ..... | No permanent relief. | No permanent relief. | ..... | Died 10 days later from infection. |
| Thymectomy. | ..... | 4.25 | ..... | Complete relief second day. | Immediate disappearance. | Died from infection 6 days later. Autopsy: 14.25 gms. thymus remained. Trachea flattened from sixth to fourteenth ring. |
| Thymectomy. | ..... | ..... | Complete relief by fourth day. | ..... | Complete relief by fourth day. | Died from diarrhea 1 month later. |
| Two successive thymectomies. | Chloroform | 5 | Complete relief. | Relief for six months; then reappearance and final relief by second operation. | Disappeared gradually after second operation. | Recovery. |
| Thymectomy. | ..... | ..... | Moderate relief. | ..... | ..... | ..... |
| Thymectomy. | Chloroform | 21.5 | Immediate and complete relief. | ..... | Disappeared gradually. | Recovery. Stridor absent 14 months after operation. Complete relief of dysphagia. |
| Thymectomy. | Chloroform | 3.1 | Complete relief in 5 months. | ..... | Complete disappearance in 5 months. | Recovery. Complete relief in 5 months. |
| Thymectomy; later thyroidectomy. | Ether | 15 | ..... | ..... | ..... | Recovery. Symptoms improved, then recurred with complete relief after thyroidectomy 6 months later. |

| No. | Name of Observer | Date of Operation | Reference | Age | Résumé of Symptoms and Pathology | Type of Disorder |
|---|---|---|---|---|---|---|
| 33 | Aviragnet and Veau | Dec. 2, 1910. | Anat. top. et chir. du thymus, Olivier, Paris, 1911. | 17 months | Dyspnea and stridor. | Tracheobronchial adenopathies taken for enlarged thymus. |
| 34 | Boissonnas | Not given. Probably 1910. | Congr. pédiatrie, 1910. Quoted by Olivier in Anat. top. et chir. du thymus, Paris, 1911. | 2 months | Constant dyspnea and stridor, trachea flattened, tumor felt in suprasternal region. | Continuous |
| 35 | Gaudier | Not given. Reported 1911. | Soc. chir. Paris, Feb. 14, 1911. | 11 months | Suffocative attacks, stridor, spasm of glottis type. Sarcoma of thymus. | Intermittent with spasm of glottis. |
| 36<br>37<br>38<br>39 | Gaudier | Not given. Probably 1911. | Anat. top. et chir. du thymus, Olivier, Paris, 1911. Brief personal communication, no details. | Not given | ..... | ..... |
| 40 | Swynghedauw, Durand and Gaudier | Not given. Reported 1911. | Echo Med. Nord., February, 1911. Quoted by Olivier in Anat. top. et chir. du thymus, Paris, 1911. | 1 year | Suffocative attacks, stridor, spasm of glottis type. | Intermittent with spasm of glottis. |
| 41 | Veau | Feb. 16, 1911. | Anat. top. et chir. du thymus, by Olivier, Paris, 1911. | 7½ months | Suffocative attacks with cyanosis. | Tracheobronchial adenopathy operated for thymus. |
| 42 | Veau and Olivier | March 6, 1911. | Anat. top. et chir. du thymus, by Olivier, Paris, 1911. | 23 days | Constant dyspnea with suffocative attacks and stridor. | Continuous |
| 43 | Veau | March 11, 1911. | Anat. top. et chir. du thymus, Olivier, Paris, 1911. | 4 months | Dyspnea, suffocative attacks and cyanosis, dilatation of veins of neck, dysphagia. | Tracheobronchial adenopathy operated for thymus. |
| 44 | Veau, Olivier and Jean Dubois | March 15, 1911. | Anat. top. et chir. du thymus, Olivier, Paris, 1911. | 1 year | Constant dyspnea with suffocative attacks and stridor appearing at 9 months. | Continuous |
| 45 | Veau and Chatelin | March, 1911. | Thése Malavialle, Montpellier, 1911. | 15 months | Little's disease, suffocative attacks, convulsions, spasm of glottis type. | Intermittent with spasm of glottis. |
| 46 | Parker & Churchill | May 25, 1911. | Reported in this article. | 13 months | Suffocative attacks with cyanosis and stridor, spasm of glottis type. | Intermittent with spasm of glottis. |
| 47 | Chas. Mayo | Aug. 31, 1911. | Ann. Surg., July, 1912. | 11 months | Constant dyspnea from birth with convulsions and cyanosis. | Continuous |
| 48 | D'Oelsnitz | Not given. Probably 1911. | Bull. Soc. d. Péd. d. Paris, June, 1911. Reported by Olivier in Anat. top. et chir. du thymus, Paris, 1911. | 21 months | Suffocative attacks and wheezing respiration. | Tracheobronchial adenopathy; operated for thymus. |
| 49 | Buford & Walker | March 26, 1912. | Unpublished. Reported by courtesy of Dr. Buford. | 4 months | Constant dyspnea since birth, stridor and cyanosis. | Continuous |
| 50 | Buford & Soper | April 2, 1912. | Unpublished. Reported by courtesy of Dr. Buford. | 1 year | Convulsions, stridor, cyanosis, spasm of glottis type. | Intermittent with spasm of glottis. |

WITH IMMEDIATE AND REMOTE RESULTS. FROM 1896 TO APRIL, 1912—CONTINUED

| Type of Operation | Anesthetic | Amount of Gland Removed, gms. | Result of Operation on Permanent dyspnea. | Result of Operation on Suffocative Attacks | Result of Operation on Stridor. | General Results and Autopsy Findings |
|---|---|---|---|---|---|---|
| Thymectomy. Intubation. | Chloroform | 2 | ..... | ..... | ..... | Died 7 days later. Autopsy: Numerous enlarged tracheobronchial lymph-glands. |
| Thymectomy. Tracheotomy. | Ether | 20 | Immediate relief with some recurrence from bronchitis. | ..... | Disappeared gradually. | Died 18 days after operation from bronchopneumonia. |
| Thymectomy. | No anesthetic. | 5 | ..... | Immediate and complete relief. | Complete relief. | Died 3 days later, bronchitis and hiccough. Autopsy: large portion of gland remaining in chest. Sarcoma of thymus. |
| Thymectomy. | ..... | ..... | ..... | ..... | ..... | Recovery in all. |
| Thymectomy. | ..... | 9 | ..... | Immediate and complete relief. | Immediate and complete relief. | Recovery. |
| Thymectomy. Removal of lymph-nodes, drainage. | Chloroform | ..... | ..... | ..... | ..... | Did well for over a month but died later. |
| Thymectomy. | Chloroform | 15 | Immediate and complete relief. | Immediate and complete relief. | Gradual and complete relief. | Recovery. In good health 6 months later. |
| Thymectomy. Removal of lymph-nodes. | No anesthetic | ..... | ..... | ..... | ..... | Died 4 days later. Autopsy: Lungs and spleen filled with tubercles |
| Thymectomy. Intubation. Tracheotomy. | ..... | 8 | Temporary relief only. | Temporary relief only. | ..... | Died 4 days later. Autopsy: Congestion of lung with mucopus in bronchi; 16 gms. of thymus. |
| Thymectomy. | ..... | 4 | ..... | No relief. | ..... .... | Died several days later. Autopsy: 12 gm. of gland remaining. No infection. |
| Thymectomy. | Ether | 9 | ..... | Relief almost immediate. | Immediate and complete relief. | Recovery. One year later in excellent condition. |
| Thymectomy. | ..... | ..... | Immediate relief becoming permanent. | ..... | ..... | Good recovery. Six mos. later in good condition. |
| Thymectomy. | ..... | ..... | ..... | ..... | ..... | Died 3 hours later. Autopsy: Tracheobronchial adenopathy. |
| Thymectomy. | Ether | ..... | Greatly relieved. | ..... | Greatly relieved. | Recovery. |
| Thymectomy. Bronchoscopy | Ether | ..... | ..... | ..... | Relief. | Died 5 days later of lobar pneumonia. |

sign—and frequently the increased *x*-ray shadow, with the absence of other known causes, confirm the diagnosis.

Laryngismus stridulus is eliminated by the absence of the peculiar hoarse barking cough. Spasm of the glottis from insufficiency of the parathyroid secretion resembles this condition most closely and it may be impossible to distinguish the one from the other. When the hypertrophy can be established the thymus should be removed, and in doubtful cases, Hutinel believes that even if the thymus cannot be proved the cause, its removal ameliorates the spasm and diminishes greatly the danger of sudden death. Thus in either case the treatment of the intermittent form is essentially surgical.

Olivier speaks of a *"forme cyanotique"* as a separate group that was first described by Marfan. He refers to eight cases in the literature with but one operation. This was Denecke's case. The child was a male 5 years old. When he was a little over a year old the parents noticed that when he cried his face became cyanotic and he lost consciousness. Soon after there appeared a tumefaction in the lower part of the neck that at first appeared only when the infant cried, but later appeared on coughing or even speaking. When first observed by Denecke, at 5 years, at the least agitation the veins of the neck became swollen and the face cyanotic. During this time there was present a slight stridor. In spite of the absence of corroborative physical signs he made a diagnosis of compression of the veins at the root of the neck by an enlarged thymus and performed a thymectomy which greatly diminished the frequency and severity of the attacks, though it did not control them. In this connection it may be mentioned that certain dry forms of eczema in infants have been considered to be of possible thymic origin, and Lesage several years ago proposed in this form, that had hitherto so frequently resulted in sudden death, trying thymectomy. No instance of operation for this condition has been reported, although a rather extensive eczema that was present in the case reported by the writer cleared up very soon after a thymectomy.

A complete list of the cases operated on to date, fifty in all, is shown in the accompanying table.

### ANALYSIS OF CASES OPERATED ON

It will now be of interest to consider the results of treatment in the fifty cases of which we have records. First, as to mortality. Of the fifty cases operated on, seventeen died, showing a mortality of 33⅓ per cent. An analysis of the deaths, however, will show that the operation is much more benign than these figures suggest. In passing it may be observed that all cases are included in a new field of surgery wherein the mortality is likely to be higher than in an older field of established procedure.

The seventeen fatal cases, according to operators (see accompanying table). were as follows: Enderlen, No. 9; MacLennan, Nos. 15, 16, 17; Morse-Murphy, No. 19; D'Oelsnitz, Prat and Boisseau, No. 25; Vignard and Sargnon, No. 27; Aviragnet and Veau, No. 33; Boissonnas, No. 34; Gaudier, No. 35; Veau, Nos. 41, 43; Veau, Olivier and Jean Dubois, No. 44; Veau and Chatelin, No. 45; D'Oelsnitz, No. 48; Buford and Soper, No. 50.

The Morse-Murphy patient died sixteen days after operation; cause not given. But it is known that a resection of the manubrium was made, which increases the severity of the operation greatly. In four operations of this type two patients died. It is no longer practiced. So late a death, however, may not be due to the operative act itself. The same may be said of Lexer's case, reported by Tiling, in which the patient died from diarrhea some time after the operation, after the child had returned home to its parents. MacLennan states that none of the three deaths reported by him was the immediate result of the operation, but they were secondary to a spasm of the glottis and a progressive enfeeblement of the heart. In one case of D'Oelsnitz and Prat the thymectomy was done after several attempts at tubage, which had increased the cyanosis and distress. The child died three hours later.

The patient of Veau and Chatelin was a sufferer from Little's disease with frequent convulsions and permanent contractures and the co-existence of an enlarged thymus. The child died several days after the operation without an infection of the wound or other evidence of its part in the causation of death. In Buford's case a bronchoscopy was done before the thymectomy which led to a pneumonia several days later. In this group of eight cases the operation can only indirectly, if at all, be blamed for the deaths.

Of the nine remaining cases four were in the service of Veau. The first was a child with permanent dyspnea. Forty-eight hours after the operation dyspnea reappeared and a tracheotomy became necessary. This wound extended to the thymus wound and infected it, the child dying three days later from asphyxia, with a temperature of 40 C. The second child died from infection fifty days after a thymectomy with removal of tracheobronchial lymph-nodes. The third child died four days after operation for a condition similar to that existing in the second. The death was due to asphyxia and infection. The fourth child also had tracheobronchial lymph-nodes removed at the operation and did well, but died from syncope the seventh day when an unskilful attempt at intubation was made.

The fifth case was that of D'Oelsnitz, Prat and Boisseau. The child was semi-comatose when operated on. A tracheotomy and a resection of the manubrium complicated conditions. The child died several days

later from asphyxia and infection. The sixth case, that of Boissonnas, died eighteen days later from bronchopneumonia. A tracheotomy had also been performed. Gaudier's patient died forty-eight hours after operation from hiccough and bronchitis. The patient of Vignard and Sargnon died seven days after operation without closure of the cervical wound, from infection. Enderlen's patient had an abscess from spondylitis. A tracheotomy was performed. Death from bronchitis occurred one week later. In four cases where tracheotomy was done the child died; usually from infection with asphyxia. Four cases suffering from tracheobronchial adenopathy contribute to the mortality. From this analysis of cases Olivier comes to the following conclusions: "Thymectomy in itself, without drainage or tracheotomy or ablation of septic organs, such as infected lymph-nodes, has no operative mortality. The shock is never sufficient to hasten the death of the child. It is an operation by itself benign."

### RESULTS ACCORDING TO TYPES OF CASES AND WITH RESPECT TO SPECIAL SYMPTOMS

Thirty-two cases belong to the continuous type, if we include the six cases of MacLennan which Olivier includes in his classification. This leaves the four cases of Gaudier unclassified on account of too meager data. Eight cases belong to the intermittent type, one to the cyanotic variety (Denecke's), and one is associated with Graves' disease in an adult (Garre's). In the thirty-two cases belonging to the continuous type there were nine deaths and twenty-three recoveries.

The persistent dyspnea in this type disappeared immediately and completely in fifteen cases. In one of these it reappeared after eight months and gradually disappeared after a second operation. Two died later from bronchitis. In five cases the relief was complete only after the lapse of several days and in one case, five months. One of these died one month after the operation from diarrhea. In four cases the relief from dyspnea was incomplete or moderate, or "improved." One of these died sixteen days after the operation. In one case the relief was temporary with death four days later, and in another there was no permanent relief, death occurring from infection ten days later. In the six cases of MacLennan this symptom was not given in the available histories. Thus in the twenty-six cases in which this symptom was mentioned the dyspnea was eventually completely relieved in twenty, or over 75 per cent. of the cases.

The occurrence of suffocative attacks was mentioned in fifteen of the continuous type of cases. In twelve cases these disappeared immediately and completely after operation, although in one of these it reappeared six months later to permanently disappear after a second operation. One died a week later from bronchitis. In one case the relief was gradual

and in two others it was only temporary or absent, both patients dying a few days after the operation. These attacks were thus suppressed in thirteen out of fifteen cases.

Stridor was mentioned as a symptom seventeen times in the continuous type, six times in the intermittent type and once in the cyanotic variety — twenty-four times in all — or in approximately one-half the cases. It disappeared immediately after operation in ten cases. In eleven others the relief was more gradual though not always complete. In one it was very slight, in another it reappeared when the child cried and in another it gradually disappeared after a second operation. Thus the stridor was suppressed or diminished in nearly every case.

In the intermittent form there were eight thymectomies with four cures or improvement, and four deaths. Suffocative attacks occurred in seven of these. In six there was immediate or remote suppression of the attacks. In one there was no relief. Three of this seven eventually died.

In the single dysphagic case of Hinrichs the dysphagia was immediately relieved and the child swallowed without trouble shortly after the operation. In the cyanotic case of Denecke the relief was great, though the cure was not complete. The improvement in the general health is particularly noticeable in many cases as one might well expect after relief from serious respiratory obstruction.

## CONCLUSIONS

Many sudden deaths in infants have been caused by an enlarged thymus producing obstruction of the trachea.

Frequently this is the sole factor responsible for the compression, but at times enlarged tracheobronchial glands or spasm of the glottis are contributing factors in producing the fatal result. Compression of the trachea is shown at autopsy by the presence of a flattened trachea associated with the enlarged thymus, and is revealed *intra vitam* by the bronchoscope showing the narrowed lumen of the organ, the symptoms referable to which being completely relieved by thymectomy. The diminished caliber has also been demonstrated by intubation, only a long tube sufficing to keep the trachea open, and immediate and permanent relief following removal of the gland.

Two general types of cases are observed, the continuous type in which the symptoms usually date from birth or soon after with permanent dyspnea usually present, and the intermittent type, usually of later development, in which there are longer or shorter intervals free from symptoms.

The three most important symptoms in either type are permanent dyspnea, recurring suffocative attacks and stridor. All three of these frequently occur together, when their presence is an imperative indica-

tion for immediate operation. The presence of either one of the first two symptoms is an equally imperative indication for operation. Stridor alone is not an indication for thymectomy.

The treatment is essentially surgical. Operative treatment—thymectomy — is as necessary and effective in tracheal obstruction from the thymus enlargement as tracheotomy or intubation are for obstruction higher up. It is frequently an emergency operation.

Although the accumulating evidence is strongly suggestive that the thymus gland is absolutely necessary to life and normal development in the earlier stages of growth, its operative removal in the young human subject, as far as present evidence has shown, is not fraught with the slightest untoward metabolic disturbances. This is probably due to the fact that it is never completely removed and that the remaining portion quickly reproduces the tissues of the organ. It may also be in man, as in the lower animals, that after a certain period of growth its function is taken up by other organs, as the thyroid and spleen, and its complete removal, if it were possible, would have no baleful influence on the organism.

Of the seventeen recorded deaths that occurred in thymectomized children, four followed a complicating tracheotomy and one an unclosed wound with drainage and infection. Four were due to infection from septic tracheobronchial glands. In one there was a preliminary bronchoscopy and in another there had been several unsuccessful attempts at tubage immediately preceding the operation. In three cases with incomplete histories the operator expressly stated that the deaths were not due to the operation itself. One was in a severe case of Little's disease. And, finally, in two cases the deaths occurred several weeks after operation from causes remote from if not entirely separate from the operative procedure. In no case was the operation immediately fatal.[16]

Intracapsular thymectomy is the only type of operation now employed. The vertical median incision terminating about 1 cm. below the upper border of the sternum is the skin incision usually employed. This is the one used in Veau's operation. The low transverse incision has been successfully employed in a few cases.

General anesthesia is usually well borne when competently given.

The operation is easily and safely performed.

7 West Madison Street.

16. Since preparing this paper I have learned that Dr. W. E. Schroeder, of this city, performed a successful thymectomy on a child in February, 1912.

# ANGIOMA OF THE LARYNX, ESPECIALLY ITS RELATION TO CHRONIC LARYNGITIS

## WITH REPORT OF A CASE IN A CHILD NINE MONTHS OLD, FOLLOWING MEASLES. REVIEW OF THE LITERATURE

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Angioma of the larynx is a very rare condition. In a careful review of the literature we have been able to find twenty-six cases. The following case is therefore considered worthy of report:

*History.*—Baby H., male, aged 9 months, came under observation August 10, 1912, because of difficulty in breathing. The family history threw no light on the case. The baby had been breast-fed since birth and was well nourished.

The present trouble dated from an attack of measles in May. Following this for a period of one month, there was hoarseness, with some difficulty in breathing, and a "croupy" cough. This gradually improved so that for a period of two or three weeks scarcely any abnormality of breathing could be noticed. Three weeks prior to this report he began to have increased hoarseness, some cough, and dyspnea, the inspiration being accompanied by a stridor. This has grown progressively worse and the only relief that could be given was from large doses of ipecac. Following the vomiting which this produced, the child breathed somewhat easier for a few minutes. His dyspnea has always been worse at night than during the day.

*Physical Examination.*—The child was unusually well nourished; skin and mucous membranes were cyanotic; it was extremely restless. There was great difficulty in breathing, with loud inspiratory stridor, and marked dilatation of the alae nasi. The tongue was coated, tonsils normal, and there was no bulging of the posterior pharyngeal wall. The child was unable to nurse because of the difficulty in breathing. All the accessory muscles of respiration were brought into play; there was retraction of the supraclavicular spaces and epigastrium, with a marked projection forward of the sternum. The lungs were normal except for an area of dulness at the left base posteriorly, extending from the angle of the scapula to the base. Over the same area there could be made out no abnormality of breathing, because the inspiratory stridor obscured all other sounds. The rate of respiration was 40 to the minute. The heart showed nothing unusual except some enlargement of the left ventricle. The *x*-ray examination of the chest showed no growth in the mediastinum. The pulse-rate was 140. The rest of the physical examination revealed nothing abnormal. Because of the extreme restlessness no laryngoscopic examination could be made. The temperature was 105 and the leukocyte count was 50,000. Because of the presence of pneumonia and the moribund condition of the child a tracheotomy was not considered advisable. The child grew gradually weaker and died the next day.

### NECROPSY PROTOCOL

*Anatomical Diagnosis.*—Stenosis of the larynx; chronic catarrhal laryngitis; chronic inflammatory hyperplasia of the laryngeal mucosa; hemangioma simplex of the larynx; early lobar pneumonia of the lower lobe of the left lung; slight fragmentation of the myocardium; slight hypertrophy of left ventricle.

*Inspection.*—The body is that of a well developed, well nourished child of 9 months. Rigor mortis is slight. There is a moderate amount of *post mortem* staining in dependent portions. The skin is soft and free from scars, pigmentations or edema. There is a slight dusky hue around the face and neck. The superficial lymph-nodes are not enlarged. The head is well formed. The eyes, ears, nose and throat show nothing unusual. The chest is broad and deep; the abdomen rounded and the genitalia and extremities are normal.

*Section.*—The skin is thin and the panniculus adiposus quite thick, light-yellow and moist. The muscles are of a deep red color. The sternum, costal cartilages and ribs are normal. The lungs lie free in the pleural cavities. There are no adhesions, but in the left pleural cavity are about 20 c.c. of a clear yellowish fluid. The thymus is not enlarged. The mediastinal lymph-nodes are of the usual size. The right side of the heart is dilated.

Pericardium: The pericardium is thin, smooth and glistening. There are no adhesions. The pericardial sac contains 5 c.c. of a clear, yellowish fluid. The heart weighs 18 grams; the right auricle and ventricle are considerably dilated and contain dark fluid blood and soft clots. The left auricle is slightly dilated; the left ventricle is firmly contracted. The endocardium throughout is smooth and glistening; the valves show no abnormality. The myocardium of the left ventricle is considerably thicker than usual.

Lungs: The entire right and the upper lobe of the left lung are air-containing throughout. The lower lobe of the left lung, however, is considerably increased in consistency. On pressure it pits slightly and is not crepitant. The pleura is roughened and is of dull red color. Over its surface are a few strands of fibrinous exudate. On section it cuts easily; the cut surface is moist, dark red, and slightly granular. On pressure there exudes a dark red, slightly frothy fluid. Macroscopically the bronchi and vessels show nothing unusual.

Larynx and Trachea: On removing the larynx and on external inspection, it appears quite normal. On looking down between the vocal cords, however, marked changes are found. Instead of the characteristically shaped chink between the true vocal cords, there is only a very small slit-like aperture with granular edges. On opening the larynx over the anterolateral portion of the wall and extending from the true vocal cords down to the third ring of the trachea, there is a reddish-gray growth with quite an irregular and granular surface. Opposite the lower border of the thyroid cartilage there is a slightly larger growth of a deeper red color and with a more irregular surface. The lumen of the larynx and upper part of the trachea is greatly narrowed by this growth. The greatest narrowing is at the true vocal cords where the opening measures 1.5 by 3 mm.; the diameter of the larynx, just below the cords from cartilage to cartilage is 9 mm. The thickness of the mucosa at this point is 3 mm. The point of the greatest thickening is at the lower border of the thyroid cartilage, where the mucous membrane measures 4 mm. The diameter of the lumen of the trachea below the growth is 8 mm., while at the latter it is only 3 mm., at the widest point.

*Microscopical Examination.*—The heart, aorta, thymus and mediastinal glands show no remarkable pathologic changes. The lower lobe of the left lung shows an early lobar pneumonia.

Larynx: The pathologic changes in the larynx are confined to the mucosa and show marked differences in the various regions. Just below the vocal cords there is a great thickening of the mucosa. This depends on an increase in all of the elements, but more especially in the fibrous connective tissue. Towards the lumen the tissue is densely infiltrated with mononuclear leukocytes and plasma cells. Thin-walled engorged vessels are quite numerous and the mucous glands, which normally in this region are rather small, are quite large and show evidences of an active hyperplasia. In places they are considerably distorted by the overgrowth of the surrounding connective tissue. The lumina of the glands and their ducts are filled with a faintly basic-staining

homogeneous material in which a few mononuclear cells are found. The gland cells stain deeply and the nuclei are very large. The epithelium of the larynx is absent in not a few regions, and here the tissue is densely infiltrated with round cells and the surface is covered by a small amount of a cellular exudate. The tissue in this region is quite edematous.

Sections made from portions of the larynx lower down show varying grades of gland and connective tissue, hyperplasia and chronic catarrhal changes. Here also thin-walled vessels are quite prominent.

Near the lower border of the thyroid cartilage in the region which macroscopically appeared of a deeper red than elsewhere, very interesting changes are found. Here, as in other portions of the laryngeal mucosa, the glandular elements are hyperplastic, but instead of being imbedded in an edematous, infiltrated, fibrous, connective tissue, they are compressed and distorted by what appears to be a true hemangioma simplex. The main portions of the tissue is composed of numerous, small tortuous vessels with thin walls and quite prominent endothelium which in places seems to be more than one layer in thickness. The vessels lie very near each other, the interstitial tissue being composed of numerous spindle shaped cells. All the vessels are filled with blood.

In a critical review of the literature we have been able to find twenty-six undoubted cases of angioma of the larynx. These, with our own case, bring the total to twenty-seven. Cases have been reported by various authors which can hardly be classed among the true angiomata. Among these may be mentioned a case by Hooper[1] of a richly vascular papilloma of cavernous structure, and another of Fedele,[2] which proved to be a fibro-angioma of the right vocal cord. Eppinger[3] has described a case of fibroma hemangiectaticum of the larynx that could not be included in the series. Vitto-Massei[4] has reported a case of large gray tumor of the left sinus pyriformis in a man, 50 years of age, which proved to be a connective tissue growth poor in cells and containing cavernous blood-spaces. A varix of the left aryteno-epiglottidean fold has been reported by Juffinger.[5] Wingrave,[6] in a study of fifty cases of innocent laryngeal growths, encountered ten cases of angiofibroma and one of angiomyxoma. Hirsch,[7] in describing one true angioma, mentions two other cases in which the tumors were richly vascular, but he himself did not think they could be included among the true angiomata.

No age is exempt, but the majority of cases occur during middle life. The oldest recorded case was in a patient 62 years of age, and the youngest was our own, which was 9 months. The proportion of males to females is approximately four to one.

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1. Hooper: Med. Rec., New York, 1884, xxv, 562.
2. Fedele: Osservatore, Gaz. d. clin. di Torino, 1878.
3. Eppinger: Path. Anatomie des Larynx und der Trachea, Aug. Hirschwald, Berlin, 1880.
4. Vitto-Massei: Internat. Centralbl. f. Laryngol., Rhinol., etc., Berlin, 1907, xxiii, 68.
5. Juffinger: Wien. klin. Wchnschr., 1891, xlii, 760.
6. Wingrave: Jour. Laryngol., Lond., 1906, xxi, 215.
7. Hirsch: Wien. klin. Wchnschr., 1908, xxi, 592.

ETIOLOGY

The etiology of angioma of the larynx is obscure. Chiari[8] brings up the question, as do many authors, as to whether the angiomata do not directly follow a chronic hyperemia and catarrh of the laryngeal mucosa. Grant[9] states that such growths as fibromata, fibropapillomata, fibroadenomata, cysts and angiomata are best explained as the results of inflammatory conditions. In many cases he says the sequence of events is from an acute to a chronic inflammation, with such subsequent hyperplasia as to constitute a tumor. Pegler,[10] in discussing the cases of Symonds[11] and St. Clair Thomson,[12] thought that angiomata were granulomata with dilated capillaries and admixture of fibrous tissue. In favor of the prevailing supposition that angiomata of the larynx follow inflammatory conditions is the fact that there is a history of the latter in almost every case. The preponderance of males, who from exposure are more subject to laryngeal catarrh than the opposite sex, would be confirmatory evidence. In our own case a laryngitis accompanying measles was present three months before the symptoms referable to the tumor were noticed. From this observation, together with a critical review of the reported cases, we feel justified in assuming that the majority of cases of angioma of the larynx are the result of a previous inflammatory condition.

*Symptoms and Diagnosis.*—There are two types of angioma of the larynx, viz., angioma simplex and angioma cavernosum. The latter type is much more common. The angioma simplex generally occurs as a flattened tumor, while the angioma cavernosum has a roughened surface. All authors agree that great care must be taken in the diagnosis of these tumors, as not infrequently vascular papillomata, fibromata, and especially varices are erroneously called angiomata.

In the majority of cases the symptoms at the time the patient comes under observation are well marked. In the discussion of the etiology of angiomata of the larynx, we alluded to the fact that in a large number of the patients there was a history of chronic laryngitis, often extending over a period of years. The most frequent symptoms are cough, hoarseness, feeling of foreign body in the larynx, aphonia, difficulty of breathing and expectoration of mucus often streaked with blood. Occasionally, as in our own case, the larynx may be almost completely obstructed, and thus cause death. Loomis reports one case in which very serious hemorrhage

8. Chiari: Arch. f. Laryngol. u. Rhinol., 1896, v, 100.
9. Grant: Jour. Laryngol., Lond., 1904, xix, 637.
10. Pegler: Jour. Laryngol., Lond., 1905, xx, 337.
11. Symonds: Jour. Laryngol., Lond., 1905, xx, 337.
12. St. Clair Thomson: Jour. Laryngol., Lond., 1905, xx, 337.

occurred. The diagnosis is usually easy from laryngoscopic examination, if the age and condition of the patient permits; in our own case this was impossible.

### TREATMENT

The treatment consists in the removal of the tumor, which usually can be easily accomplished by the galvano-cautery or other measures. The hemorrhage is usually not troublesome.

### ABSTRACTS OF REPORTED CASES

The following cases we have abstracted from the literature:

Fauvel:[13] Male, aged 53, of good general health; complained of hoarseness, without cough or pain. A non-pedunculated red tumor, of black color in spots, was found situated in the angle of the vocal cords. The tumor was about the size of a filbert, and was successfully removed.

Coupard[14] reports an angioma of the vocal cord, but the paper was not available.

Heinze:[15] Male, aged 38, of poor health, being anemic and weak. Had long-standing pharyngeal and laryngeal catarrh with hoarseness. A tumor the size of half a lentil was found at the border of the right ventricular fold, near the anterior commissure. Behind this, separated by a free interspace, there was another tumor of about one-half the size of the previous one. Both were reddish-black in color, round and uneven. They were successfully removed at operation.

Elsberg:[16] Male, aged 37; complained of increasing hoarseness of six years' duration. For twelve years had a nasopharyngeal catarrh which he thought had gradually involved the larynx. At time of examination there was a slight hoarseness and considerable mucus in throat, but no pain. A tumor the size of a pea was found attached by a thin, dark pedicle to the right vocal cord near the anterior commissure. This on microscopic examination was found to be an undoubted cavernous angioma.

Elsberg:[16] Male, aged 28; had had whooping-cough and diphtheria in infancy, and for many years had catarrh. For the previous five years, after excessive use of voice, he became aphonic. Gradually he became very hoarse, and on examination, a tumor of the vocal cord was found. This tumor was reddish-black in color, smooth and pyriform in shape. It was attached to the edge of the right vocal cord and extended from the anterior commissure back for at least one-third of the length. The diagnosis was angioma and it was successfully removed.

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13. Fauvel: Traite pratique des maladies du larynx, v, Adrien Delahaye et Cie., 1876, 545.
14. Coupard: Rev. mens. d. laryngol., 1880-81, i, 311.
15. Heinze: Arch. Laryngol., 1880, i, 135.
16. Elsberg: Arch. Med., 1884, xi, 12.

Kidd:[17] Female, aged 50; complained of loss of voice, which progressed gradually during a period of eight or more years. The tumor was small, oval, imperfectly bi-lobed, dark red and finely granular. It sprang from the upper surface of the left vocal cord. Microscopic examination showed it to be a true angioma.

Seiler[18] reports case of true angioma of right vocal cord (quoted by Wolfenden).

Thurber:[19] Male, aged 31; complained of hoarseness, developing after a cold, three years before examination. He had no dyspnea. One year after hoarseness developed he had an attack of laryngitis, during which time he spit up some bloody mucus. Examination revealed a purplish tumor, half an inch in diameter covering the laryngeal opening, but not interfering with motion of the vocal cords. The microscopic diagnosis was angioma.

Wolfenden:[20] Male, aged 44; complained of hoarseness and at times a sensation of foreign body in the larynx, with dryness of the throat, with occasional expectoration of blood. Examination revealed a large bright red tumor, situated on the surface and edge of the right ventricular band, occupying the posterior two-thirds, and completely hiding the vocal cord except at its anterior third. The growth had the appearance of a small raspberry. A second much smaller growth of similar appearance was found at the anterior extremity of the left vocal cord. The breathing was never interfered with. The tumor was not operated on.

Schwarz[21] (quoted by Wolfenden) has reported a case of submucous capillary angioma of the larynx.

Desvernine:[22] Male, aged 53; complained of occasional bleeding from the throat and at one time had a severe hemorrhage. Examination showed a pedunculated angioma of the epiglottis.

Brown:[23] Male, aged 26; complained of uneasy sensation for three weeks. The upper surface of both vocal cords was a dusky red color, and the entire interlaryngeal mucous membrane was hyperemic. The secretions were increased, and on the left ventricular band, occupying almost its entire upper surface, was a somewhat oval-shaped vascular tumor of a uniform gray color except in the center, which was bright red, becoming purple after repeatedly phonating. The patient was not treated.

Beau[24] (quoted by Chiari) reports two cases of angioma of the larynx.

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17. Kidd: Brit. Med. Jour., 1888, i, 584.
18. Seiler (quoted by Wolfenden): Jour. Laryngol., Lond., 1888, ii, 291.
19. Thurber: Laryngoscope, 1911, xxi, 878.
20. Wolfenden: Jour. Laryngol., Lond., 1888, ii, 291.
21. Schwarz (quoted by Wolfenden): Jour. Laryngol., 1888, ii, 291.
22. Desvernine: Revista de ciencias Medicas, 1888.
23. Brown: Jour. Respir. Org., 1889, i, 40.
24. Beau (quoted by Chiari): Arch. f. Laryngol. u. Rhinol., 1896, v, 100.

Loomis:[25] Female, aged 62; had a tumor the size of an English walnut on the side of the tongue, one involving the left side of the pharynx and another in the neck. These had been present since birth. Eight months later the patient was seen, and at that time was in a critical condition, with cyanosis of the face, intense dyspnea and difficulty of speech. Six hours before death she passed per rectum 16 ounces of blood. At autopsy, in addition to the tumors of the tongue, pharynx and neck, there was found two angiomatous tumors of the larynx, one the size of a large pea, projecting from the ventricle of the larynx on the left side, and the other the size of a cherry at the lowest part of the aryteno-epiglottidean fold.

Fauvel:[26] Male, aged 37; suffered with severe hoarseness, lasting several months, with sudden attacks of aphonia without appreciable cause. A pea-sized tumor, blackish-red, smooth and slightly pedunculated, was situated on the free edge of the left vocal cord near its anterior insertion so as to prevent approximation of the cord. It was removed at operation with complete cure. The microscopic examination showed it to be a cavernous angioma.

Mackenzie[27] observed two cases of angioma of the larynx. Both were of blackberry-like appearance in color, form and size. One grew in the right hyoid fossa and the other in the right ventricular band.

Chiari:[8] Male, aged 28; complained of throat trouble. On examination there was a chronic catarrhal pharyngitis and marked hyperemia of the laryngeal mucosa. A bluish nodule the size of a hempseed was found on the right vocal cord. Chiari was inclined to think this was a varix after a complete microscopical examination, but Billroth, in the discussion, thought that it was a cavernous angioma.

Brady:[28] Boy, age not given; complained of dyspnea, hoarseness and expectoration of blood. A cherry-sized, deep red, rough tumor was found below the anterior commissure of the vocal cords. The tumor bled easily. It was successfully removed and proved to be an angioma.

Symonds:[11] Male, aged 30; had recurring colds in his head followed by hoarseness and sensation of lump in the larynx on the right side. A purple, vascular, hard, lobulated swelling was found on the right side overhanging, but not involving the cord. The ventricular band was lost in the swelling and the anterior edge of the vocal cord was just visible on phonation. The diagnosis was angioma.

Thomson[12] (in discussion of Symond's case) said that he had seen a similar growth in a patient 25 years of age, in which there was a bluish

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25. Loomis: Proc. New York Path. Soc., 1890, p. 30.

26. Fauvel: Traite pratique des maladies du larynx, v, Adrien Delahaye et Cie., 1876, p. 606.

27. MacKenzie: Diseases of the Throat and Nose, Presley-Blakiston, Phila., 1880, i, 307.

28. Brady: Jour. Laryngol., 1901, xvi, 14.

infiltration under the ventricular band. There were no symptoms except when treated.

Malzeu[29] described a case in which a tumor weighing 14 grams, situated on the arytenoid cartilages, hung down into the entrance of the larynx. The examination showed a cavernous angioma.

Hirsch:[7] Female, aged 22; complained of hoarseness. A tumor involving the whole right cord and another on the anterior third of the left cord, including the ventricle, was found. Both tumors were bluish-red, and about the size of a raspberry. The surface of the right was warty, the left smooth. The diagnosis was hemangioma cavernosum.

Glasgow:[30] Patient had complained of hoarseness for six months. There was a slight impediment of speech. At times there was a sudden break in the voice, which was cleared by a short cough. Laryngoscopic examination showed a grayish-brown lobulated tumor, the size of a large pea attached to the left vocal cord. The diagnosis was angioma cavernosum.

Ferreri[31] (quoted by Glasgow) reports a case of angioma the size of a hazel-nut situated on the inferior part of the left vocal band. This was crushed by means of forceps, and despite the application of ferric chlorid and a tracheotomy, violent hemorrhage took place. Death from pneumonia ensued within forty-eight hours.

3849 Prospect Avenue.

29. Malzeu: Mitt. der Baz. Klinik, 1907, ii, 56.

30. Glasgow: Amer. Jour. Med. Sc., 1889, xcvii, 300.

31. Ferreri (quoted by Glasgow): Amer. Jour. Med. Sc., 1889, xcvii, 300.

# OSTEOGENESIS IMPERFECTA. REPORT OF A CASE WITH THE STUDY OF ITS METABOLISM *

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Osteogenesis imperfecta was one of the diseases which entered into the symptom-complex known as fetal rickets, which gave rise to much discussion during the latter half of the last century. It was Vrolik,[1] in 1849, who first described an intra-uterine case in detail and gave it the name of osteogenesis imperfecta. Parrot, in 1878, removed from this group the disease known as achondroplasia, this differentiation being later made more complete by works of Kaufman and his scholars, Dieterlin[2] and Schwenderer[3] (1899 and 1906). Stilling,[4] working under von Recklinghausen, did the first pathologic work, which made osteogenesis imperfecta an entity, and of late the work of Sumita,[5] Looser[6] and Fuchs[7] have continued to emphasize its independent characteristics.

In 1833 Lobstein[8] called attention to cases characterized by fragility of the bones and gave them the name osteopsathyrosis, showing that there was among them a group which was termed idiopathic, for which no definite etiologic factor, such as syphilis, tuberculosis, bone tumors or trophic neurologic conditions, could be ascertained. For a long time idiopathic osteopsathyrosis occurring after infancy, frequently in early childhood and also later in life, was considered as a disease entirely distinct from the congenital condition before referred to as osteogenesis imperfecta; but as more cases were carefully examined and described clinically and pathologically, especially by Nathan,[9] Looser[6] and Sumita,[5] the two conditions were found to be identical.

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*From the Chemical Laboratory of the Cornell University Medical School and the Out-Door Maternity Clinic.

1. Vrolik: Quoted by Frangenheim (Note 10).
2. Dieterlin: Virchow's Arch. f. path. Anat., 1906, clxxxiv.
3. Schwenderer: Untersuch. über Chondrodystrophie fetalis, Inaug. Dissert., Basle, 1899.
4. Stilling: Virchow's Arch. f. path. Anat., 1899, cxv.
5. Sumita: Deutsch. Ztschr. f. Chir., 1910, cvii.
6. Looser: Mitt. a. d. Grenzgeb. d. Med. u. Chir., 1906, xv, 161.
7. Fuchs: Virchow's Arch. f. path. Anat., 1912, ccvii, No. 1.
8. Lobstein: Lehrbuch der path. Anat., 1835.
9. Nathan: Am. Jour. Med. Sc., January, 1905.

Osteogenesis imperfecta may therefore be described as a disease characterized by excessive fragility of the bones, for which no definite cause can be found.

By far the greater number of cases occur during intra-uterine life and are still-born. Some, however, as the case to be described further on, survive and present a definite clinical picture. Another group includes the cases which appear to be apparently normal at birth, but later on at some time of life, usually in childhood, suddenly develop a tendency to multiple fractures from very little violence. Many authors are of the opinion that the disease in these cases is also congenital, but that the process has lain dormant. This question is summed up by Frangenheim[10] as follows:

> In our opinion osteogenesis imperfecta and idiopathic osteopsathyrosis present one clinical picture which is not histologically comparable to any known disease of the skeleton which proceeds with atrophy and softening; its chief symptom, abnormal fragility of the bones, appears at birth or soon after birth, but it may also first show itself in early or late childhood after a certain period of latency.

## ETIOLOGY

Heredity seems to be the only important factor in this disease, many authors having observed several cases in the same family. Griffiths,[11] who collected sixty-seven cases, found distinct evidence of the hereditary character of the disease in eighteen. Gurl[12] has compared the disease to hemophilia, believing that it is transmitted especially to males through unaffected females. Syphilis does not seem to be an etiological factor, and in our case the Noguchi modification of the Wassermann reaction was negative. As far as the ductless glands are concerned, the thyroid origin of the disease has been denied by Sumita,[5] who examined several cases and found histologically normal thyroids. It is interesting to note that the disease has been present at birth in one of twins, the other child being perfectly normal. This would tend to show that the actual condition of the mother was at fault, and that the condition is a true fetal disease.

## PATHOLOGY

The pathologic anatomy of the disease has been thoroughly investigated, among others by Sumita,[5] Lovett and Nichols,[13] Looser,[6] Stilling,[4] Harbitz,[14] and lately by Fuchs.[7] Microscopically, the bones show fractures, either recent or healed, callus being usually small. The breaks are often very numerous, as many as 113 being reported by Chaussier[15]

10. Frangenheim: Erzeg. der Chir. u. Orthoped., 1912.
11. Griffiths: Am. Jour. Med. Sc., 1897, cxiii.
12. Gurl: (Quoted by Griffiths, Note 11).
13. Lovett and Nichols: Brit. Med. Jour., Oct. 13, 1906.
14. Harbitz: Ziegler's Beitr., 1901, xxx.
15. Chaussier: (Quoted by Griffiths, Note 11).

in a new-born child. The bones may be soft and pliable or very brittle. They may be either normal in length or short and plump, scarcely narrower in the middle than at the ends. The fractures are irregularly placed so that the bones have been compared by Hohlfeld[16] to bamboo rods. Whether the bones are shortened without the presence of fractures is an open question. Fuchs believes that the bones may be short owing to deficiency in ossification due to a diminution in the number of

Fig. 1.—Authors' case of osteogenesis imperfecta.

osteoblasts. The cortex of the bone is extremely thin, and in the case of Michel and H. Muller, quoted by Frangenheim, the entire diathesis consisted of a firm membranous periosteum filled with a red-brown mass intersected by fine bony spicules.

The bones of the skull are characteristic, in that they are almost entirely devoid of calcification, the cranium being soft and pliable, a

16. Hohlfeld: München. med. Wchnschr., 1905.

condition known as calvaria membranacea. The base of the skull, on the other hand, is ossified, but is thin and friable. The ribs are usually ossified, but show irregularly distributed nodules, representing previous fractures.

Microscopically, the bones show the following:

> The region between epiphysis and diaphysis of the long bones show normal relations in respect to the proliferation of the cartilage, the form, structure and arrangement of the cells. Endrochondral ossification *per se* proceeds normally but is markedly reduced in amount. In the diaphyses one meets with numerous thin, cartilage remnants, but with very few bone trabeculæ. Periosteal ossification is entirely absent in certain places, in others it is slight. The periosteum is thin and the condition might be spoken of as marked dystrophia periostalis. The number of osteoblasts is everywhere diminished, and in the long bones the marrow is markedly increased. (Quoted from Fuchs, see Note 7.)

## SYMPTOMS

The majority of these infants are still-born and are easily recognized by the deformities due to the multiple fractures. Some cases survive, however, and during their infancy present a typical picture which, when once seen, is easily distinguished from that presented by cretinism, Mongolism and chondrodystrophy. The children are small and underweight; have long, silky hair; the fontanels and sutures are wide open, and ossification is so retarded that the head feels soft and boggy, having been likened to a parchment bag. The face is small, the nose and mouth perfectly formed and the tongue is not enlarged. The skin is soft and delicate. The thorax shows no deformity excepting small knob-like excrescences on the ribs, due to old fractures; these may be as numerous as five or six on one rib. The abdomen is protuberant, without any evidence of umbilical hernia or diastasis recti. The extremities show all sorts of deformities due to fractures and bending, marked shortening and curvature being the rule. Some cases show very exquisite fragility of the bones, so that the slightest manipulation causes new fractures; others, as the case to be described below, seem to have passed through this stage *in utero* and present only the malnutrition and the deformities. In still other cases the children are apparently normal in infancy, but in childhood the tendency to fractures after very slight violence begins to manifest itself. The fractures seem to cause very little pain, and the union takes place rather rapidly.

The *x*-ray appearance of the bones shows large medullary cavities with very thin atrophic cortex; epiphyseal lines showing up fairly sharply.

The prognosis of the disease is bad, as those infants not still-born usually die within a short time after birth. The prognosis of the cases occurring later in childhood is better, as some of them seem to undergo spontaneous cure. Many, however, have to live in constant dread of new

fractures, and these lead to such deformities that a number of cases have come to amputation. Drugs and organotherapy have proved equally useless.

CASE REPORT

*History.*—E. B., second child, of Russian parentage, 7 months old when first seen. Family history negative as to syphilis, tuberculosis or any other bone disease similar to this one. The other child is three years old and perfectly normal.

Fig. 2.—Radiograph illustrating the bones of the skull, face, spine and ribs.

No miscarriages. Mother thinks the patient was born in cephalic position. Deformities present at birth resemble those now seen. When the child was four days old a physician found a fracture of the right thigh, and the limb was put in plaster for two weeks. Mother knows of no other fractures.

Child was breast-fed for five months, then received both breast and cow's milk. Has gained very little in weight, though nourishment is well taken. Except for under-development and presence of deformities, the child seems well.

*Physical Examination.*—Female child, weight 7 pounds 8 ounces; appears bright, follows objects, unable to hold up head or to move head from side to side; head appears abnormally large in comparison with trunk, which is short and broad, with especially prominent abdomen; extremities small, shortened, curved and angulated. Length 50 cm.

Head: Asymetrical, left side (on which child is apparently accustomed to lie) is flattened. Circumference 42.5 cm. Mastoid to mastoid circumference 35.5 cm. Occipitofrontal circumference 29.5 cm. Anterior fontanel 8 cm. by 7 cm. Posterior fontanel 10 cm. by 6.5 cm. Sagittal suture wide open. Temporal bosses well marked. Eyes: distinct exophthalmos; eye-brows and lashes well formed. Nostrils firm and delicate. Mouth small. Lips thin. Tongue protrudes slightly. Ears small and well formed. Hair silky, 10 cm. to 12 cm. long, light brown. Chest circumference 31 cm. Clavicles show angular deformity. Ninth rib in scapular line shows knobs the size of a pea. Heart and lungs negative.

Abdomen: Circumference 31.5 cm.; prominent; no hernia. Liver, 4 cm. below border of ribs in the mammary line. Spleen just palpable one finger below costal border, hard.

Lymph-nodes just palpable the size of a pea in axilla and groin.

Extremities: Humerus, length 6 cm., olecranon to index finger 11.5 cm. Lower extremities show marked angular deformity. Urine clear, amber, acid, no albumin, no sugar.

Blood: Hgb. 60 per cent.; red blood-cells, 4,512,000; white blood-cells, 11,600. Differential: Polynuclear leukocytes, 15.5 per cent. Large mononuclears, 17 per cent. Small lymphocytes, 64.5 per cent. Eosinophils, 2.5 per cent. Basophils 0.5 per cent.

Noguchi modification of the Wassermann reaction negative. (Kindness of Dr. D. J. Kaliski.)

*X-Ray Findings.*—The long bones show marked curvatures, but fractures are present only in the ribs. The cortex of the long bones is extremely thin, in many places showing only as a fine line. The medullary cavities appear to be filled up with tissue giving a mottled irregular picture and with only indefinite spicules of bone present. We are indebted to Dr. Jaches for the beautiful radiographs.

Metabolism Experiment.—The child was placed in a Hoobler metabolism bed for six days. During this time it was fed on a mixed human milk obtained from the Out-Door Maternity Polyclinic. The weight of the child at the beginning of the experiment was 3,400 gms.; at the completion 3,430 gms. The mother's own milk during this time was collected and from a sample of about 800 c.c. an analysis was made (Table 1).

TABLE 1.—MILK ANALYSIS OF PATIENT'S MOTHER

| Amt., c.c. | Fat, gm. | Protein, gm. | Sugar, gm. | CaO, gm. | MgO, gm. | $Na_2O$, gm. | $K_2O$, gm. | $SO_3$, gm. | $P_2O_5$, gm. |
|---|---|---|---|---|---|---|---|---|---|
| 100 | 2.95 | 0.969 | 6.28 | 0.0354 | 0.0075 | 0.0430 | 0.0889 | 0.0267 | 0.0288 |

From a consideration of Table 1 it will be seen that the constituents of the mother's milk are not in fault, as it is apparently normal, except for a somewhat low percentage of protein and fat. The mixed breast milk given the child was obtained from a number of different women in various stages of lactation and at various times of the day, and an aliquot part of the day's feeding was kept for analysis. The child received six feedings a day of 100 c.c. each, an intake of 100 calories per kilo. Analysis of this milk is shown in Table 2.

**Fig. 3.—Radiograph showing the bones of the skeleton.**

TABLE 2.—ANALYSIS OF MIXED HUMAN MILK USED AS FOOD DURING EXPERIMENT

| Amt., c.c. | Fat, gm. | Protein, gm. | Sugar, gm. | CaO, gm. | MgO, gm. | $Na_2O$, gm. | $K_2O$, gm. | $SO_3$, gm. | $P_2O_5$, gm. |
|---|---|---|---|---|---|---|---|---|---|
| 100 | 3.06 | 1.22 | 7.0 | 0.0423 | 0.0057 | 0.048 | 0.0820 | 0.0282 | 0.02617 |

During the six days' experiment the child took 3,900 c.c. of milk. There was no vomiting and the temperature was normal. With the first and last feedings charcoal was given and appeared in the stool about eight hours later. There was one stool a day, normal in appearance and consistency. The stools were mixed, dried at 60 C., then weighed and analyzed. The urine varied from 158 to 250 c.c. a day; the specific gravity was 1.005 to 1.010. Daily total nitrogen and nitrogen-partitions were obtained. Aliquot parts of the remaining urine were added together and used for the inorganic analyses.

Four days after the completion of the experiment the child was put in the frame again for twenty-four hours and urine obtained for creatin and creatinin determinations. Throughout duplicate analyses were made.

TABLE 3.—URINE ANALYSIS

| Days | Amount, c.c., Sp. Gr. | Total Nitrogen | Urea N., gm. Per cent. Total N. | Ammonia N. gm. Per cent. Total N. | CaO, gm. | MgO, gm. | $K_2O$, gm. | $Na_2O$, gm. | $SO_3$, gm. | $P_2O_5$, gm. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 245 | 0.449 | 0.350 | 0.058 | ..... | ..... | ..... | ..... | ..... | ..... |
| | 1.008 | ..... | 75.7 | 10.7 | ..... | ..... | ..... | ..... | ..... | ..... |
| 2 | 155 | 0.459 | 0.352 | 0.056 | ..... | ..... | ..... | ..... | ..... | ..... |
| | 1.010 | ..... | 76.2 | 10.0 | ..... | ..... | ..... | ..... | ..... | ..... |
| 3 | 158 | 0.450 | 0.347 | 0.041 | ..... | ..... | ..... | ..... | ..... | ..... |
| | 1.008 | ..... | 77.1 | 9.3 | ..... | ..... | ..... | ..... | ..... | ..... |
| 4 | 218 | 0.633 | 0.444 | 0.097 | ..... | ..... | ..... | ..... | ..... | ..... |
| | 1.005 | ..... | 70.1 | 10.6 | ..... | ..... | ..... | ..... | ..... | ..... |
| 5 | 230 | 0.817 | 0.630 | 0.051 | ..... | ..... | ..... | ..... | ..... | ..... |
| | 1.010 | ..... | 77.1 | 6.2 | ..... | ..... | ..... | ..... | ..... | ..... |
| 6 | 255 | 0.698 | 0.584 | 0.049 | ..... | ..... | ..... | ..... | ..... | ..... |
| | 1.008 | ..... | 83.5 | 7.2 | ..... | ..... | ..... | ..... | ..... | ..... |
| Tot. | ..... | 3.506 | ..... | ..... | 0.126 | 0.0823 | 2.2505 | 0.5422 | 0.8070 | 0.2688 |

As seen from the tables the nitrogen metabolism is approximately normal. The child has an absolute retention of 423 mg. a day, 35 per cent. of the intake, or 124 mg. per kilo. This absolute retention with a utilization of 35 per cent. corresponds to the normal child of 3 to 4 months. Rubner and Heubner[17] in a 5-months'-old child showed an absolute retention of 48 mg. per kilo and a utilization of about 23 per cent. The relationship of the age to the absolute retention, however,

17. Rubner and Heubner: Ztschr. f. Biol., 1898, xxxvi.

only holds good in normal children, and not in one so much under weight as this one. The excretion of urea and ammonia are within normal limits.

During the day on which the child's urine was collected for creatin and creatinin determination there was an intake of 1.18 gm of nitrogen. It excreted 370 c.c. of urine, containing 657 gm. of nitrogen. Ten mg.

Fig. 4.—Radiograph from a different angle showing the bones of the pelvis and lower extremities.

creatinin nitrogen was excreted in twenty-four hours, or about 3 mg. per kilo. This is low as compared to Amberg and Merrill's[18] findings of 6 to 9 mg. per kilo. Creatin was present to the amount of 2.5 mg. in twenty-four hours.

18. Amberg and Merrill: Jour. Biol. Chem., 1907.

The fat retention and resorption are perfectly normal. The calcium metabolism is of particular interest in the light of the disturbance in the ossification of the bones. It is seen from Table 4 that the child is retaining calcium to the extent of 45.7 per cent. of the intake. The calcium retention when viewed from this standpoint is likely to lead to false conclusions, as has been pointed out lately by Orgler.[19] The truest view is obtained when the retention is based, not on the per cent. of intake, but on an absolute amount retained. Blauberg's[20] baby of 5 months, with an intake of 272 mg. a day, retained 175 mg. and remained well. According to Orgler, in ten breast-fed babies there was a retention of 130 to 210 mg. *pro die*. In eleven bottle-fed babies there the retention was about the same. However, the variations possible may be seen from Tobler and Noll's[21] case, in which a baby of 2½ months taking 239 mg. had an absolute retention of only 54 mg., and yet did not show any abnormality in ossification, either at the time or when seen five months later. Our case showing a retention of 109 mg. does not, therefore, appear to be very low, the average figures being 120 to 210 mg.

TABLE 4.—BALANCES IN SIX-DAY METABOLISM EXPERIMENT

Total food=3,390 c.c. milk. Total urine 1,261 c.c. Total feces 17.5 gm.

| Element | Intake Total gm. Pro Die | Urine Total gm. Pro Die | Feces Total gm Pro Die | Urine and Feces Total gm. Pro Die | Retention Absolute, gm. | Retention Per cent. |
|---|---|---|---|---|---|---|
| Nitrogen | 7.169 | 3.506 | 1.1202 | 4.6262 | + 2.5428 | .... |
| | 1.195 | 0.584 | 0.1867 | 0.7710 | + 0.4238 | 35.4 |
| Fat | 103.73 | ..... | 2.4972 | 2.4972 | +101.2368 | .... |
| | 17.289 | ..... | 0.6162 | 0.6162 | + 16.8728 | 97.5 |
| CaO | 1.4339 | 0.1260 | 0.653 | 0.7790 | + 0.6549 | .... |
| | 0.2389 | 0.0210 | 0.109 | 0.1298 | + 0.109 | 45.7 |
| MgO | 0.1819 | 0.0823 | 0.0064 | 0.0887 | + 0.0923 | .... |
| | 0.0303 | 0.0137 | 0.0010 | 0.0147 | + 0.0155 | 51.4 |
| $Na_2O$ | 1.457 | 0.5422 | 0.2216 | 0.7638 | + 0.6932 | .... |
| | 0.243 | 0.0903 | 0.0369 | 0.1273 | + 0.1155 | 47.6 |
| $K_2O$ | 2.987 | 2.2505 | 0.3640 | 2.6145 | + 0.3685 | .... |
| | 0.497 | 0.3750 | 0.0606 | 0.4357 | + 0.0614 | 12.3 |
| $P_2O_5$ | 0.8872 | 0.2688 | 0.2414 | 0.5102 | + 0.3771 | .... |
| | 0.1479 | 0.0448 | 0.0402 | 0.0850 | + 0.0628 | 42.5 |
| $SO_3$ | 1.2475 | 0.6809 | 0.2485 | 0.9294 | + 0.3181 | .... |
| | 0.2069 | 0.1134 | 0.0614 | 0.1549 | + 0.0530 | 25.5 |

The only other case in any way similar to this, in which the metabolism has been studied, is one reported by Bookman[22] in an adult male, who suffered from fragility of the bones, with a healed fracture five weeks before the time of the experiment. However, this case presents also marked muscular atrophy, and is therefore evidently a different

19. Orgler: Ergebn. der inn. Med. u. Kinderh., 1912, viii.
20. Blauberg: Ztschr. f. Biol., 1900, No. 40.
21. Tobler and Noll: Monatschr. f. Kinderh., 1910, ix.
22. Bookman: Arch. Int. Med., 1911, viii, 675.

condition from that of the child we are describing. Bookman finds a markedly negative calcium balance, and likens his results to those of McCrudden[23] obtained in osteomalacia. In both of these conditions the calcium in the already-formed bone is being liberated and thrown out of the system, and the negative balance is thus easily explained.

The positive calcium balance in our case might be construed in different ways. First, the disease may be considered at an end, especially as there have been no fractures since birth; and the calcium metabolism might be looked on as that of a normal child. But against this view is the fact that the cranial bones are still so soft and show such a markedly diminished power of ossification. Second, the disease may be in the stage of repair, and this would seem likely from the fact that there have been no fractures since birth. But if the body is trying to replace the lost calcium, there should be a decidedly greater retention of calcium than is present in the normal child. However, this is not the case; in fact, as was shown above, the retention is even a little below the normal.

On the other hand, it might be argued that in conditions such as this disease, the calcium balance might again remain positive, the calcium being deposited in other tissues than the skeleton. On this point we quote from McCrudden:

> King, Bigelow and Pearce[24] have shown that the calcium content of the bones decreases in cases of obstructive jaundice in which the calcium is needed to neutralize the toxic effect of the bile acids. Schmidt[25] has pointed out that the decrease of calcium in the bony system in rickets is accompanied by an increase in this element in the soft tissues such as muscle and liver, and Higbee and Ellis,[26] in a recent paper on Osteitis Deformans, a condition that is recognized as one of localized osteomalacia, state that calcification of the arteries is so common in these cases that it has been mentioned as a possible etiological factor.

On the other hand, Aschenheim and Kaumheimer[27] have recently shown that the calcium content of rachitic muscle is distinctly diminished, which does not add support to this theory of altered location of the calcium deposits.

When the histologic picture of osteogenesis imperfecta is called to mind and the marked diminution of calcareous tissue is noted, one would naturally be led to suppose that in the acute stage of the disease there should be a negative calcium balance, for the intake of calcium is sufficient, and, as in the normal child, all but 0.01 per cent. of the total calcium in the body is laid down in the skeleton, it would seem that with this depot for storing calcium removed, the ingested calcium

23. McCrudden: Arch. Int. Med., 1912, ix, 273.
24. King, Bigelow and Pearce: Jour. Exper. Med., 1911, xiv, 148.
25. Schmidt: Verhandl. der Deutsch. path. Gesellsch., 1909, xix, 3.
26. Higbee and Ellis: Jour. Med. Research, 1911, xxiv, 43.
27. Aschenheim and Kaumheimer: Monatschr. f. Kinderh., 1911, No. 8, p. 435.

must be again excreted. It may be well to recall in this connection how complicated the whole calcium metabolism is, when perfect ossification can take place with a retention of only 54 mg. a day, as was the case in the baby reported by Tobler and Noll and above referred to. Such a case as our own case leads one to speculate as to whether there is a direct relationship between calcium retention and skeleton ossification.

The retention of magnesium was 51 per cent., which, though somewhat higher than that of Blauberg's[20] case, shows very little difference in the actual retention (15 mg. as compared with 17 mg.).

The phosphorus metabolism is practically normal. In Blauberg's case of 5 months weighing 6,700 gm., and Michel and Peret's[28] weighing 4,700 gm., there was a retention of 45 per cent. of the intake. Our case weighing 3,400 gm. retained 42.5 per cent. of the intake. The absolute retention of 62.8 mg. in our case is much less than in the two above quoted—93 mg. and 122 mg., respectively; but our intake is only half as great, as our child weighed a great deal less.

The sodium and potassium are both positive, but a discussion of their significance is impossible in view of the small number of the existing analyses in normal infants. For the same reason the sulphur balance cannot be adequately discussed. Our figures for $SO_3$ in both the mixed breast milk and the mother's milk are very much higher than the few analyses we were able to find in the literature (282 mg. and 266.4 mg. per liter in our own analyses). Blauberg found only 143 mg. of $SO_3$ per liter, and Soldner[29] found 96 mg. per liter. However, if the sulphur be reckoned according to the protein content, it would seem that the higher figures are theoretically more nearly correct. The retention of 25.5 per cent. of sulphur corresponds very well with the retention found by one of us[30] in a normal child of 5 years.

METHODS EMPLOYED

Total nitrogen: Kjeldahl's method.
Fat: Method of Kumagawa and Suto.
Creatin and Creatinin: Folin's method.
Urea: Benedict's method. Folin's method.
Ammonia: Folin's method.
Uric acid: Folin's method.
Phosphorus and Sulphur: Method of Wolff and Osterberg.
Calcium: After ashing weighed as CaO.
Magnesium: After ashing weighed as MgPO.
Sodium and Potassium: Platinic chlorid method.

We wish to express our thanks to Professor Stanley R. Benedict of Cornell Medical College for numerous helpful suggestions given us during the course of this work.

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28. Michel and Peret: Bull. Soc. d'obst., Paris, 1899.
29. Soldner: (Quoted by Sommerfeld, Handbuch. der Milchkunde.)
30. Schwarz: Jahrb. f. Kinderh., 1910, lxxii.

# CONGENITAL ATRESIA OF THE ESOPHAGUS, WITH REPORT OF THREE CASES

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Congenital atresia of the esophagus is everywhere considered one of the rare anomalies. Sir Morell Mackenzie[1] (1884), after an exhaustive search could collect only sixty-two cases from the literature, and added only one of his own. Shukowsky,[2] with a hospital experience of 50,000 new-born babies, saw only one case. And yet within a period of one year three of these cases came under my observation, and I have knowledge of at least one other within the following year.[3] Even more striking was Hirschsprung's[4] experience, who, in 1861, in Copenhagen, with only 180,000 inhabitants, saw four of these cases within a period of seven months. Although such grouping is a matter of chance, yet one cannot help but wonder whether these cases are not more frequent than we have been led to think.

The cases here reported were all under exact observation in hospitals, and in each instance a complete autopsy was obtained.

While many different kinds of congenital anomalies of the esophagus are described, one type is the rule (70 + per cent.). This is the so-called "inosculating type," in which the upper end of the esophagus ends in a free dilated pouch, while the lower end passes from the stomach into the trachea (or, very rarely, into a bronchus). This predominance of one type suggests a uniform embryologic origin. This interesting feature will be discussed fully elsewhere by Professor Zeit,[5] and I refer anyone interested in that phase of the subject to his paper. My own report will be chiefly clinical, together with some theoretical considerations that naturally suggest themselves.

The cases that I have seen have all been, as were Hirschsprung's,[4] of the predominating type. So distinctive and uniform were the clinical features in all of them that it was easy to venture an exact anatomic

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1. Mackenzie, Sir Morell: A Manual of Diseases of the Throat and Nose, 1884.
2. Shukowsky and Baron: Archiv für Kinderheilkunde, Bd. 58, 1912, pp. 191-8.
3. Since writing the above John Lovett Morse, in the Archives of Pediatrics, July, 1912, has reported having seen three cases in the past year, with one autopsy.
4. Hirschsprung: Den Medfodte Tillerkning of Spiseroret. Copenhagen, 1861. Also Hospitalstidende, 1895, No. 42.
5. Zeit, F. R.: Med. Research, 1912, xxvii, No. 1.

diagnosis, *ante mortem*, as was done in the second and third babies, after having followed the first. A detailed description will be given of the first case only, the others so closely resembling it that only the differences will be pointed out.

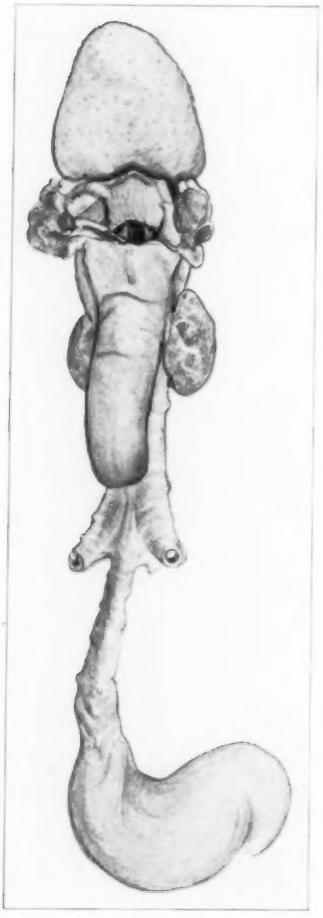

Fig. 1.

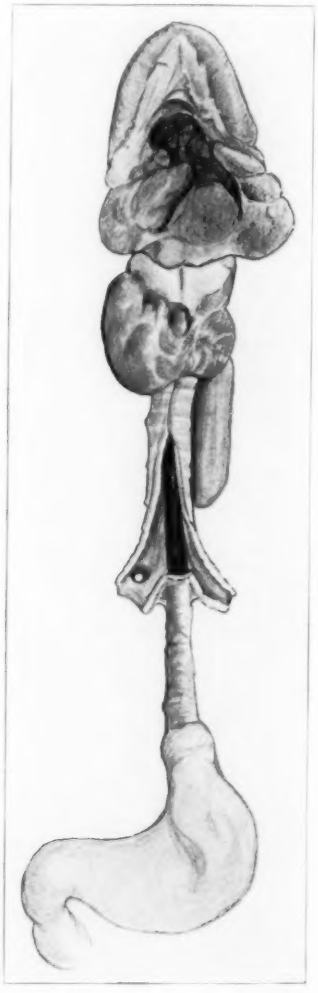

Fig. 2.

Fig. 1.—Congenital atresia of the esophagus, posterior view. Case 1. The dilated upper end of the esophagus is shown extending from below the rima glottidis to the bifurcation of the trachea; the narrower lower portion from the stomach into the trachea at the bifurcation. Drawn by Miss E. Von Stoesser.

Fig. 2.—Same as Fig. 1, anterior view. Upper dilated end of the esophagus partly hidden by the thyroid gland and the trachea. The lower portion of the trachea and the bronchi are laid open showing a sound (black) passing from the stomach through the lower portion of the esophagus into the trachea at the bifurcation. Drawn by Miss E. Von Stoesser.

## CASE REPORTS

CASE 1.—Baby O., colored, born at full term in St. Lukes' Hospital Feb. 6, 1910, on Dr. Paddock's service. Family history negative. Birth-weight 5 pounds 9 ounces; length 45 cm. Outside of the fact that it had a very low temperature (92 F.) a few hours after birth the baby attracted no special attention until it began to expel mucus from the mouth. Four hours after birth the nurse recorded "Spitting up mucus"; two hours later, "Mucus drawn from throat by intern." On the following day she recorded: "Mucus almost continually coming from nose"; and following a teaspoonful of water, "Water coming back through the nose." On the third day she recorded (baby taken) "to mother; almost strangled; milk came back through nose." Because of the complete inability to retain anything the child was transferred to the pediatric service on the third day.

The baby was manifestly in an alarming condition, was emaciated, had lost nearly a pound, the skin was dry and the tissues were beginning to feel hard; the eyes were sunken—in short there was the typical appearance of a baby long deprived of water. From the lower angle of the mouth there flowed a constant stream of stringy mucus and saliva, running over and excoriating the cheek and chin. In front of each nostril there was a considerable quantity of white, frothy discharge that bubbled to and fro with each respiration. When the child was nursed or given water from a bottle it swallowed greedily, but after one swallow the milk or water came back through the mouth, and in jets from both nostrils, synchronous with each act of swallowing. Then with the first breath it would suddenly stop nursing, would cough, become deeply cyanotic, and look as if it were choking to death. After expelling the water by coughing, and especially if the baby was inverted, it would gradually return to normal. *The upper part of the abdomen was somewhat distended, the lower part rather flat.*

A rubber catheter inserted through the mouth and always ending abruptly at a distance of about 12 cm. from the lips, clinched the diagnosis. The normal distance to the cardiac end of the stomach is about 17 cm. in the new-born.

Mouth feeding was discontinued after the diagnosis was made and normal salt solution and peptonized milk were given by rectum. On the fifth day the baby was operated on by Dr. L. L. McArthur. A jejunostomy was performed and a catheter left in place for feeding. Although the operation was well borne the general condition grew steadily worse; the baby withered and dried up perceptibly from day to day, the respirations could scarcely be seen, the pulse became imperceptible, the tissues everywhere became dry and wood-like. The baby for several days resembled an automaton rather than a living thing and died on the tenth day—a typical picture of water starvation in an infant.

On the fourth day the temperature went up to 100.2 F. and reached nearly that point every day, except the last, when it became subnormal.

The weight dropped from 5 pounds 9 ounces to 4 pounds 9 ounces on the third day and to 4 pounds and 3 ounces on the last day.

*Necropsy.*—This was performed by Dr. E. R. Le Count, to whom I am indebted for the beautifully dissected specimen shown in the illustration.

The upper end of the esophagus ended bluntly 4 cm. below the rima glottidis, and 1 cm. above the bifurcation of the trachea. It was considerably dilated, of a practically uniform diameter of 1 cm. throughout.

The lower end of the esophagus was 3 cm. long and passed directly from the normal cardiac end of the stomach into the posterior portion of the trachea just at the bifurcation. The gastric end was 5 mm. in diameter, and the tracheal end 4 mm. There was no connection whatever between the two portions of the esophagus.

Further anomalies were found in the microscopical anatomy of the spinal cord, and in the ureters. On each side there were two ureters, one normal and the other running parallel to it, and opening into the bladder by an opening close to

that of the normal ureter but distinctly separate from it. Both supernumerary ureters tapered off toward the renal extremity and ended freely, the right 4.5 cm. and the left 8.5 cm. long.

The lungs showed a bronchopneumonia.

CASE 2.—Baby N. The baby was sent to the pediatric service at Wesley Hospital from the out-patient department of the Lying-in Hospital when 3 days old, with a probable diagnosis, for obvious reasons, of bronchopneumonia. There was some fever, the breathing was rapid, both lungs were covered with moist râles, and there were spells of alarming cyanosis. The baby had retained nothing since birth.

The history of vomiting, and of spells of cyanosis, the general appearance of the child, its striking resemblance to the former case, the withered, dried-up, mask-like face and sunken fontanel, the constant flow of saliva from the mouth, reddening the chin and cheek, but, above all, the frothy, bubbly, white discharge before the nostrils that could hardly come from anything else, at once suggested the diagnosis of an atresia of the esophagus. The catheter stopping abruptly, as in the former case, at 12 cm. from the lips, fixed the diagnosis as to the upper end of the esophagus. That the lower portion of the esophagus formed a communication between the stomach and the respiratory tract was evident from the fact that the stomach was distinctly distended and tympanitic while the rest of the abdomen was slightly flattened.

On the fifth day of life a gastrostomy was performed by Dr. H. M. Richter, leaving a catheter *in situ* through which the baby was fed on breast milk. When the tube was clamped after the food was introduced, the child would soon cough, breath 100 to 150 times a minute, become deeply cyanosed, and would seem to be literally choking to death. If the tube was now opened to prevent the child from dying, the milk would well out through it, often in spurts as the child coughed. A colored fluid introduced into the stomach in this manner was recovered in part from the mouth. So alarming were the symptoms of drowning in this instance that it was not repeated. When the stomach was empty and the tube open there was an audible to and fro movement of air through the tube.

*Necropsy.*—This was performed by Dr. F. R. Zeit and the specimen forms the basis of the paper on this subject by Dr. Zeit.[5] The findings differed only in unimportant details from those of the first case. The upper sack ended blindly 1 cm. above the bifurcation of the trachea; was 4.5 cm. long, and was even more dilated (1.7 cm.) than in Case 1. The lower portion was 7.5 cm. long, and tapered from a diameter of 7 mm. at the opening into the stomach to 4.5 mm. at the opening into the mid-posterior point of the bifurcation of the trachea. There was again no connection whatever between the two portions of the esophagus. No other anomaly was found.

The lungs showed a bronchopneumonia.

CASE 3.—Baby W., born at Hotel Dieu, in the private service of Dr. G. J. Hagens, to whom I wish to express my indebtedness for permitting me to see the case together with Dr. J. H. Hess, and Dr. H. M. Richter, and also for allowing me to report it with the other two. This child had all the essential symptoms and findings of the other two and detailed description would be only repetition.

The diagnosis was established on the third day by the inability to pass the catheter into the esophagus more than about 12 cm. from the lips. It was decided that an operation was not indicated. The baby died on the eighth day. The autopsy performed by Dr. Hess showed identically the same lesion as the other two. The upper end of the esophagus was 4 cm. long, 1 cm. wide, and ended 1 cm. above the bifurcation of the trachea. The lower portion was 6 cm. long, 0.7 cm. in diameter near the stomach and slightly less at the other end. In this case the tracheal end of the lower portion of the esophagus emptied into the posterior median line of the trachea 1.5 cm. above the bifurcation.

The only other anomaly found was a single horse-shoe kidney.

Out of sixty-two cases of congenital malformation of the esophagus reported by Mackenzie,[1] forty were of the "inosculating type," such as the three here reported, and in three others the lower portion of the esophagus connected with a bronchus (70 per cent. in all). In nine cases there was a simple blind termination; in two a normal esophagus except for a fistulous opening into the trachea, and in three others there was a membranous obstruction. In five cases there was a complete absence of esophagus, but this occurred only in extreme general malformations (acardiacus). Thus about 75 per cent. of all cases in which there is any esophagus at all belong to the type here reported.

In one-third (Kraus) to one-half (Happich[6]) of these cases other anomalies are present, beside that of the esophagus.

We have in these cases of atresia of the esophagus new-born babes that are deprived of food, and what is far more vital, of water, and it is of interest to go a little deeper into the symptomatology of this almost unique condition.

*Birth-Weight.*—It is commonly stated that these babies are born small and weak. Ahlfeld[7] has attributed this to the fact that they do not swallow amniotic fluid as the normal fetus does, and, deduced from this, that the amniotic fluid helps to nourish the fetus. Schwalbe[8] does not agree with him, his own two cases being well developed and of normal weight. My cases weighed, respectively, 5 pounds, 9 ounces; 7 pounds, 12 ounces; and 7 pounds; an average of nearly 7 pounds. Ahlfeld's view seems further untenable in the "inosculating type," because we have here a passage from the mouth to the stomach by way of the trachea that is practically as patulous as the normal esophagus. It is hard to see why swallowed amniotic fluid should not find its way to the stomach by this route.

*Length of Life.*—All of the cases of the type here reported die. Mackenzie[1] reports twenty-five deaths out of thirty-seven in the first week. These of the present series lived, respectively, 9, 7½ and 8 days, under very different conditions that do not seem to have altered materially the course. Thus the first baby had a major operation and received about 30 ounces of fluids altogether, chiefly by tube into the jejunum and a small amount by rectum; the second, too, was operated and throughout its life most nearly approached absolute starvation, receiving only two saline enemas, and the rest of its fluids, water and milk, by tube into a stomach that expelled practically everything immediately; the third did not undergo an operation, and received about 2 quarts of normal salt solution by hypodermoclysis during the last four

6. Happich: Inaug. Dissert., Marburg, 1905.
7. Ahlfeld: (a) Lehrbuch der Geburtsheilkunde. (b) Missbildungen.
8. Schwalbe: Missbildungen.

days of its life, and yet lived a day less than the less well developed first baby with its more serious handicap.

*Cause of Death.*—A bronchopneumonia, as in these cases, usually terminates the picture because of the favorable conditions for the aspiration of food into the lungs. It is hard to tell how great a part this plays, as compared with pure water starvation in bringing about the fatal end. The clinical picture is that of starvation, of desiccation. The fairly uniform length of life would lead one to think that the figures so obtained nearly represent the length of time a new-born babe can live without water. While death from strangulation often seems imminent, it apparently is rarely the cause of death, although Porro reported one such death. Whether the baby is fed by mouth or not is manifestly a large factor in determining whether it shall strangle to death, or die of a terminal pneumonia; or of simple starvation.

*Loss in Weight.*—This is rapid and persistent but especially so in the first few days when the tissues are still filled with water. Thus these three infants that weighed 5 pounds, 9 ounces; 7 pounds, 12 ounces; and 7 pounds, lost, respectively, 1 pound, 1½ pounds and 2 pounds in the first three days; and a total of 1 pound, 6 ounces; 2 pounds, 6 ounces; and 2 pounds, 14 ounces. The total loss in weight was thus, respectively, about 25, 30 and 40 per cent., with nearly 75 per cent. of the loss in the first three days.

*The Temperature* in each case showed a distinct elevation after the second or third day, a phenomenon that is by no means rare in the new-born. This so-called "inanition temperature" of the new-born lasted in the first case from the fourth to the seventh day with 100.4 F. as a maximum. In Case 2 the temperature rose gradually with wide remissions from the third day to 102 F. on the last day. In Case 3 the temperature was slightly above normal the first two days, went to 102 F. on the fourth day and remained between 100 and 101.6 F. to the end. The rise in temperature toward the end was probably due to the terminal pneumonia. In Case 1, however, with a pronounced bronchopneumonia, the temperature was almost constantly subnormal during the last three days, a condition that is quite often seen with a terminal pneumonia in marantic babies.

*Sclerema.*—In each of these cases the skin became dry, leathery and non-elastic, and toward the end the subcutaneous tissue everywhere was board-like, so that the bones could not be felt as structures separate from the overlying tissues. The face became almost immovable, expressionless and mask-like. This condition is doubtless due to water starvation, and probably a solidification of the subcutaneous fat takes place.

The *meconium* did not differ in appearance from that passed by the normal new-born baby. It was possibly slightly scantier, and in Cases 1

and 3 was passed only with the aid of an enema, or suppository. In Case 2 there were two to four meconium stools a day for several days after the baby entered the hospital.

*Attacks of Suffocation and Cyanosis* occur in all of these cases depending in number and severity on whether the child is given food, or water, by mouth. They are evidently due to the aspiration into the lungs of the fluids that the child is attempting to swallow and that fill the mouth, pharynx and nasal passages. These attacks can likewise occur, in the "inosculating" cases, by flooding of the lungs with fluids from the stomach in the act of vomiting as was well shown in Case 2.

A most characteristic symptom is the constant flow of saliva from the mouth and the presence of a frothy discharge in front of the nostrils. The saliva that is normally secreted in considerable amount cannot be swallowed in these cases and must flow from the mouth. Regurgitation through the nose occurs because the mouth and nasopharynx are filled with fluid while the mouth is closed in the act of sucking. The nose is the only outlet. Both of these symptoms can hardly come from any other condition in the new-born.

*Abdomen.*—It is commonly stated that babies with congenital atresia of the esophagus have a sunken abdomen. This is only partly true. In each of these cases the epigastric region was distinctly bulging and tympanitic, while the lower part of the abdomen was flattened. This condition is manifestly due to the fact that air passes into the stomach from the trachea through the lower part of the esophagus, but not beyond the stomach. That this does happen was shown in the second case in which there was audible respiration through the catheter inserted into the stomach through the abdominal opening.

*Diagnosis.*—The diagnosis is easily made from the following symptoms:

1. Characteristic return of swallowed fluid from the mouth and through the nose in jets, synchronous with the act of swallowing.

2. The constant flow of saliva from the mouth and the presence of a frothy secretion before the nose.

3. Alarming attacks of suffocation and cyanosis with each attempt at mouth-feeding.

4. The attempt to pass a sound establishes the diagnosis and also the point of obstruction. The normal distance from the lips to the cardiac end of the stomach is 17 cm. in the new-born, and the minimum diameter of the esophagus 4 mm. (Mackenzie[1]).

5. The "inosculating" type can be diagnosticated when the stomach is found distended with air.

*Treatment.*—No treatment so far has been of any avail. To attempt to feed such an infant by mouth only hastens the fatal end. Rectal

feeding in the new-born can be only a very temporary measure. A radical operation that would aim at a *restitutio ad integrum* is hardly to be considered in the new-born and not much more so in the older child if it should survive. Hoffmann attempted it, but abandoned it for a gastrostomy.

Temporizing operations have accomplished nothing because of the practical impossibility of nourishing the child under the conditions imposed. Gastrostomy, recommended by Sedillot, has been performed a number of times (Steel, Hoffmann, Happich, Villemin, Kirmisson, Dickie, Demoulin,[9] etc.). In every case, as in Case 2, the result has been the same, the fluid introduced into the stomach has flooded the lungs, and invited death by suffocation and bronchopneumonia. It is clearly contra-indicated in cases in which a communication between the stomach and trachea has been diagnosed, and these probably constitute 80 to 90 per cent of all cases of atresia. Surgical closure of the cardiac end of the esophagus, if possible, would make this operation more rational, but would make any later radical operation still more formidable. In cases in which there is a simple blind termination of the upper end, with no lower end communicating with the trachea, simple gastrostomy would be the operation of choice.

Jejunostomy, recommended by Demoulin,[9] and performed in Case 1, would seem sounder theoretically, but it is very doubtful if a new-born infant, thus handicapped, ever could be nourished sufficiently by jejunal feeding to more than simply prolong its life a few days, to say nothing of building it up for a future radical operation. These cases are unfortunately rarely diagnosed before so enormous a loss in weight has taken place that this alone jeopardizes the child's life. Even if a child could be fed in this manner it would be doomed to perpetual feeding through a tube, and to other embarrassments that would make life unbearable; or else it would have to submit later to a radical operation that would offer little if, indeed, any hope. While the utter hopelessness of these cases, if untreated, justifies surgical procedures that would otherwise seem too daring; nevertheless the physician who, after making his diagnosis of congenital atresia of the esophagus, decides to let his little patient die undisturbed, as in Case 3, can amply justify his course.

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9. Demoulin: Bulletin Société de Chirurgie, July 5, 1904.

# THE REDUCTION OF INFANT MORTALITY IN NEW YORK CITY*

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In the reduction of the death-rate in any age group, or even from any specific cause, there is often danger in placing too great emphasis on methods in their relation to results. This dictum may be considered as particularly true with reference to infant mortality. General improved sanitation and hygiene have shown their effects in regard to the lowering of the death-rate of infants under one year of age, in much the same ratio that has obtained in the lowering of the general death-rate as it pertains to the class of cases that might reasonably be affected by such an influence.

A marked increase or decrease in the infant death-rate during a short period of time may also be misleading. Incidents are not wanting where congratulations on a lowered death-rate have been followed by a feeling of despondency when, with apparently the same conditions and methods, the death-rate has again assumed an upward tendency.

A marked instance of such a transitory reduction was noted in New York City in 1903. In that year there was a numerical decrease of 1,112 deaths under 1 year of age. The following year there was a numerical increase of 1,712 deaths for the same age period. This increase persisted with a less degree of intensity until 1908, when the division of child hygiene was organized, and the department's efforts were broadly developed along preventive lines.

In general, in New York City, the decline of the infant mortality-rate has been regular during the past three decades. During the thirty-year period from 1880 to 1910, the rate declined from 288.9 to 133.9 per thousand infants living, under 1 year of age.

Considering the causes of death as grouped in four general classes, a reduction of 70 per cent. was shown in the contagious diseases, 37 per cent. in the diarrheal diseases, 38 per cent. in the respiratory diseases and 4 per cent. in the group known as congenital diseases, including marasmus. During the period of time between 1876 and 1908, the Department of Health of New York City dealt directly with the situation in the summer months only, by detailing physicians to treat sick babies,

* Read before the Fifteenth International Congress on Hygiene and Demography at Washington, D. C., Sept. 24, 1912.

by lectures to mothers on baby care and by the distribution of educational printed matter on the same topic. These efforts were supplemented by various private charitable organizations, but it would be difficult to determine if this work had any extensive or direct result in life-saving, except as a part of a general improvement in sanitary methods.

The Department of Health of New York City states as a fundamental precept that "Public health is purchasable; within natural limitations a community can determine its own death-rate." Communities have been slow to recognize this truth, but that there is a rapidly growing recognition is known to any student of civic sentiment. In the United States the increase in interest in matters pertaining to child welfare has been marked in the past five years. Possibly in no other line of public health work has such an advance in interest been made, and of the various efforts made to conserve the health of children, "baby-saving" has made the most direct public appeal. The most impressive and significant impression made by attending a meeting of our National Association for the Study and Prevention of Infant Mortality is the various classes of people represented — physicians and trained nurses, teachers and students, social workers, philanthropists, clergy, club-women, government officials and laymen, meeting on the common ground of that great human appeal — life saving. It is this awakening of the public mind, this catholic interest, that causes even the most crowded of newspapers to print infant mortality statistics as "news," and the magazines to publish leading articles on baby saving campaigns, that has made possible the "purchasing of public health" and the saving of thousands of otherwise doomed babies.

While this movement has been felt in all civilized countries, it has expressed itself in such a concrete form in New York City that a review of the methods used and the results achieved, in themselves, are the excuse for confining the consideration of this complex problem to a purely local aspect.

The specific interest in the welfare of children to be considered as an age group was crystalized in the summer of 1908 by the formation of the Division of Child Hygiene of the Department of Health to control all public health matters affecting children from birth to puberty. The reduction of infant mortality forms one of the most important duties of the division. In order to judge the value of the methods employed, a study of the infant death-rate for the past ten years is of interest. In 1902 this death-rate was 168 per 1,000; in 1907 it was 160; the intervening years showed slight variations. In 1908, with the generous appropriation for the division, it was possible to begin the plan of preventive work in baby-saving which has since been broadly elaborated. The first year's work showed a death-rate of 144 per 1,000, a reduction of 16

points. During that and the succeeding two years it was possible to carry on the work from May to the middle of September. The members of the Board of Estimate, New York City's money appropriating power, were not yet sufficiently impressed by the need of an all-year-round campaign, although the department urged its necessity. During 1909 and 1910 a further reduction of 10 points was made in the death-rate. In the latter year a child welfare exhibit brought the matter fairly to the attention of the public, and for 1911 an appropriation was made sufficient to allow the establishment of fifteen infants' milk stations to be maintained throughout the year. Early in the spring of the same year the New York Milk Committee, a private organization, formed to forward civic interests along its specified lines, in a spirited campaign led by Mrs. J. Borden Harriman, raised sufficient funds by private contribution to open thirty-one infants' milk stations to work in cooperation with the Department of Health and demonstrate the value of this method of reducing infant mortality, the avowed intention being to maintain the stations until the city would provide for their support. The stations, together with those of the Department of Health, the New York Diet Kitchen Association, Nathan Straus, The Brooklyn Children's Aid Society, Babies Dairies, Morningside Milk Dispensary and Nurses' Settlement, gave a total of seventy-nine stations for the city. These were soon combined in an Association of Infants' Milk Stations, with uniform methods of record-keeping, reporting to a central office, and full cooperation, with elimination of duplication of effort.

The division of child hygiene, supplementing and cooperating with the stations, had 157 trained nurses making home visits to babies out of reach of the stations. Each nurse was furnished from the birth records of the Department with the names and addresses of 150 babies in the poorer congested quarters of the city. The names were transmitted to the nurse daily, immediately on receipt of the notification of the birth, until the full quota had been assigned. Each nurse was wholly responsible for the babies under her control from May 1 to September 15. With 16,987 babies under the care of the district nurses, and 11,644 under the supervision of the stations, a total of 28,631 babies were under direct control.

A campaign of wide publicity was carried on through the newspapers. Printed educational matter was freely distributed, lectures delivered to mothers at weekly intervals at over one hundred suitable places throughout the city, and the aid of over twenty thousand girls from 12 to 14 years of age was enlisted and made of practical value by the formation of Little Mothers Leagues.

These leagues are still one of the most important branches of our work. The girls are taught all practical methods of baby hygiene and

feeding. The potential value of training young girls for intelligent motherhood is not only of immense importance, but the immediate results have been striking in the improved care that is given to the babies who are directly under the care of these young girls. As true preventive work, it ranks of first importance in the prevention of infant mortality in this and the next generation. In all, 239 of these leagues were formed in 1911, and practically an equal number have been organized this year. Weekly meetings are held for instruction. Each league is under the supervision of a doctor and a nurse from the division of child hygiene.

Weather conditions during the summer of 1911 were unfavorable. The intensity and continuous duration of the heat were more marked than that recorded for any summer since 1901. At the end of the year there were recorded 1,182 fewer deaths under 1 year of age than for the previous year. This reduction took place between June 15 and September 15, and of the total reduction, 954 represented the decrease in deaths from diarrheal diseases, the class of cases against which practically the whole force of the movement had been exerted.

The experiment was carefully followed by public-spirited citizens. The Board of Estimate, composed of men keenly alive to and in sympathy with movements tending towards increased efficiency in civic welfare, appropriated for use in 1912 sufficient funds to establish forty additional infants' milk stations, giving a total of fifty-five under the control of the division of child hygiene of the Department of Health. The intelligent generosity of the city government exemplified the truism that "public health is purchasable" with the recognition that infant mortality is a public health problem and that it is the duty, as well as the privilege, of the government to assume, in a broad sense, the responsibility for this most important public health problem. Enough additional money was appropriated to increase the staff of nurses, so that increased registration at the milk stations might be adequately handled. The force of district nurses was also augmented.

At present one nurse and an assistant are assigned to each station during the entire year, with an additional nurse and assistant from May 1 to October 1, leaving a total of two hundred nurses, including a supervising force, available for district visiting in the care of babies for the summer months. One physician is detailed to each three stations except during the summer, when each station has the continuous service of one physician. In all, 130 physicians are employed for station assignments and for supervisory work in cooperation with the nurses in caring for delicate and ill babies in their homes.

While the reduction in the infant death-rate for 1911 had been extremely gratifying, it was evident, from an analysis of the statistics of former years, that definite conclusions as to the actual value of the

methods employed could not be accepted without qualification when based on the results of one year's activity. The year 1912 was therefore viewed with some trepidation. The New York Milk Committee and the Brooklyn Children's Aid Society, feeling that they had demonstrated the value of infants' milk stations in baby-saving and, with the conviction that the municipality should assume full responsibility for the infant mortality problem, withdrew from the field, thus closing thirty-eight stations, the forty new ones opened by the city giving a net gain of only two, not only to hold the gain in the reduction of the death-rate, but, if possible, to make it greater.

The grouping of the infants' milk stations in an association served to emphasize the need of still stronger cooperation among the various agencies in the city whose activities brought them into more or less direct contact with infant welfare work. There are approximately 150 such agencies in New York City, and they have heretofore worked, for the greater part, quite independently of each other. Duplication of effort in many lines has been encountered, with a resulting great loss in efficiency.

TABLE SHOWING DEATHS AND DEATH-RATES OF CHILDREN UNDER ONE YEAR OF AGE, BASED ON THE ESTIMATED POPULATION AT THAT AGE
NEW YORK CITY

| | ——All Causes—— | | Diarrheal Diseases | |
|---|---|---|---|---|
| Year | Deaths | Rate | Deaths | Rate |
| 1902 ..... | 15,526 | 168. | 4,090 | 44.28 |
| 1903 ..... | 14,413 | 151. | 3,769 | 39.56 |
| 1904 ..... | 16,125 | 164. | 4,726 | 48.08 |
| 1905 ..... | 16,522 | 163. | 4,945 | 48.75 |
| 1906 ..... | 17,188 | 164. | 4,943 | 47.08 |
| 1907 ..... | 17,437 | 160. | 5,314 | 48.90 |
| 1908 ..... | 16,231 | 144. | 5,118 | 45.45 |
| 1909 ..... | 15,976 | 137. | 4,254 | 36.45 |
| 1910 ..... | 16,212 | 134. | 5,807 | 47.97 |
| 1911 ..... | 15,030 | 120. | 3,853 | 30.70 |
| 1912, to Sept. 1. | 9,868 | 113. | 2,218 | 25.47 |

Early this year the executive committee of the Infants' Milk Station Association invited all of the agencies to federate under the title of the Babies Welfare Association. The response was immediate and enthusiastic. A central office, with an executive secretary, was established at the Department of Health. An executive committee was formed, with one member to represent each class of interests. Subcommittees were formed with a membership including representatives from all organizations in the city dealing with the particular form of baby welfare work of the specified committee.

The subcommittee on milk stations has as its province the study of the present stations, for the purpose of producing more complete cooperation among the various organizations, widening the influence of the stations, and broadening their work of relief. It has divided the city

into milk station districts, assigning one station to each district, so that the old trouble of overlapping and proselyting between milk station organizations has been practically eliminated. At the same time, these districts are to be used as a basis for recommendations as to the establishment of new milk stations. This committee is also cooperating with the committee on hospitals in working out a uniform policy governing the treatment of sick cases at the milk stations and with the committee on social service in solving relief problems. The committee is endeavoring, as far as possible, to establish uniformity of method in the stations of the various organizations and to bring about closer relations between the stations and other agencies.

The subcommittee on hospitals and dispensaries has established a central bureau to furnish daily information regarding available facilities in hospitals, dispensaries and nurseries, and to act as an agent in placing any babies referred to it by any agency in the field. Reports have been received and tabulated from nearly fifty hospitals handling baby cases, showing how many beds are available in each institution and what the conditions are for admission. Hospital cases at the milk stations are referred directly to the Executive Secretary at the central office. He has merely to refer to his records to locate the nearest hospital which is likely to have an available bed on that particular day, and, without loss of time, makes arrangements for receiving a baby. Under the old individual system, it often took a nurse at a milk station several hours, and sometimes days, to find accommodations for a little patient.

The outing agencies of the city have been similarly treated. Whenever a worker comes across a baby under 2 years of age needing a fresh air outing, the central office of the Babies Welfare Association is notified and arrangements are made for receiving the child. This branch of the work is under the direction of the subcommittee on outings. This committee is also considering the problem of establishing playgrounds for little mothers in vacant building lots. It has also taken up the question of establishing temporary shelter for well babies during the sickness of their mothers.

The committee on social service has accomplished an excellent piece of work in solving the problem of emergency milk relief. Hitherto, when a baby suffering from digestive trouble needed pure milk for which its parents could not pay, it has been necessary to report the case in writing to one of the relief societies and await their investigation, which often took a day or more. In the meantime, the baby might need that milk immediately to save its life. That meant that the cost must come out of the nurse's own pocket, if the milk were supplied. An arrangement was made with the relief societies this summer, whereby a nurse, discovering a baby in need of emergency milk relief can call up a relief agency on the

telephone, state such facts about the case as she has at hand and within fifteen minutes' time receive, also by telephone, from the relief agency a report as to whether it considers the case likely to prove worthy of charity after further investigation. In that case the relief society will pay the cost of supplying the milk while it carries on its investigation in detail. Under this system no worthy relief case is required to suffer from delay, and no nurse is required to take the price of the milk out of her scanty earnings. The distribution of free ice has also been greatly facilitated by this committee. Hitherto free tickets meant for needy families with sick children had been distributed to half a dozen agencies. As many different sets of tickets had to be printed. Now, one set of these tickets is sent out by the association to the entire field.

The committe on publicity and statistics acts as a clearing house of information between the members of the association, the beneficiaries and the public regarding all details of the work of the association. Weekly reports are received at the central office from the milk stations. The central office in turn sends out a weekly statement of mortality records and facts regarding the progress of the work. The substance of these reports is condensed in weekly or semi-weekly newspaper stories. Special articles regarding the work have been printed in the Sunday papers and magazines. Quiries are received constantly from other cities. Perhaps the most important feature of the commission's work is its educational publicity. Leaflets and folders put in simple language and sometimes translated into Italian and Yiddish, giving information about various phases of the care of babies, have been distributed by the hundreds of thousands through the tenement sections. Pocket cards giving the location of milk stations have been given to every available person in the city who is in a position to direct needy mothers to the milk stations. Every policeman and park department employee in the tenement sections has one of these cards in his pocket. A series of twelve articles on baby care have been prepared at the request of the committee and printed in the English, Italian and Yiddish newspapers which have a large circulation in the tenement districts.

There is also a subcommittee on central office, which looks after the needs of the central organization and makes such provisions as become necessary from time to time for carrying on the work. So far, there has been very little need of a treasurer or common fund. The services of an executive secretary have been provided by the New York Milk Committee and the Russell Sage Foundation has contributed the time of an investigator who has done some valuable field work for the association this summer. One secret of the success of the association has been the fact that no new appealing body has been thrust into the field. It is the general opinion that the plan is a success, and there seems to be no longer

a doubt but that the organization will be a permanent one. Cooperation without amalgamation has been brought about by the association. No organization within it in any way loses its individuality or has its methods of work encroached on.

With this impetus and cooperation, the work has been carried on by the division of child hygiene along substantially the lines followed in 1911.

At the present time it is estimated that of the 135,000 babies in New York City, 50,000 have mothers who are ignorant of the simplest methods of proper baby care and who are unable to pay for such advice, or for medical treatment in case of illness.

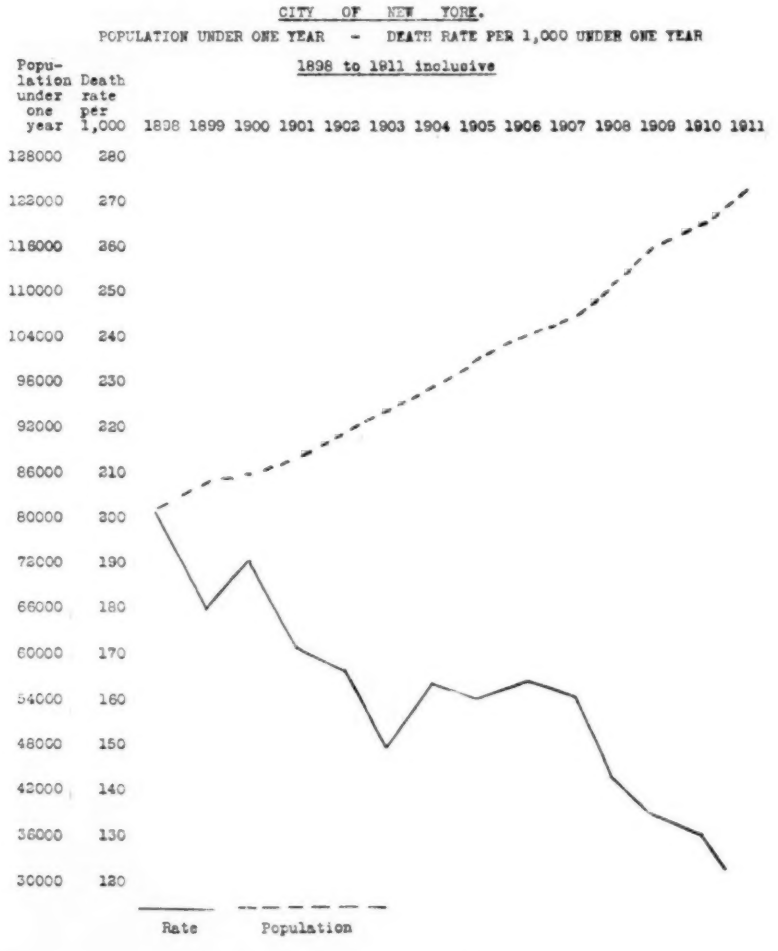
The Division of Child Hygiene has approximately 34,000 of these babies under its control; the allied agencies are caring for about 10,000 of the remainder, leaving an estimated number of 6,000 not yet reached. From January 1 to September 1 of this year there have been 576 fewer deaths under one year from all causes than for the same period of 1911. Four hundred and seventeen of this number represent the decrease in deaths from diarrheal diseases.

Possibly a more graphic method of showing the results of systematic widespread work along preventive lines may be shown by a further study of the mortality statistics. For the four-year period previous to the organization of the division of child hygiene and the assumption by it of the responsibility for the reduction of infant mortality, the infant death-rate each year showed a numerical increase amounting to a total of 3,026 deaths, while for the four years since the division was organized there has been an actual numerical decrease of 2,407 deaths. The death-rate for the four-year period from 1904 to 1907, inclusive, ranged from a maximum of 164 to a minimum of 160 per 1,000. From 1908 to 1911, inclusive, the maximum rate was 144 in 1908, and the minimum was 120 in 1911. In the division's four years of work this rate has dropped from 160 to 120 per 1,000 deaths from all causes, while the diarrheal death-rate has declined from 48.90 to 30.70 in the same period of time.

While these results have justified our expectations, we are keenly alive to the importance of further efforts along other lines. The two most important problems to be solved at present are the reduction of infant mortality from so-called "congenital causes" and among institution babies.

In New York City approximately 35 per cent. of the deaths under 1 year of age are due to causes mainly dependent on the health of the mother during her pregnancy and confinement; 32 per cent. of the deaths under 1 year occur in the first month of life, and 54 per cent. in the first three months. This problem is so complex that even with the most strenuous efforts to solve it, brilliant results cannot be expected within

the near future. The infants' milk stations, serving as educational centers, are capable of valuable aid. Early registration of pregnant women and continuous supervision following the lines already laid down by various private organizations will show beneficial results, but our whole economic and social structure must be readjusted for ultimate and permanent success. The wide difference between dealing with a few




selected cases by a compact private organization and grappling with the whole situation in a large city by government action is obvious, but we intend vigorously to follow up this line of work. These babies suffering from congenital debility furnish the greater number of victims in the annual summer increase in the death-rate. They furnish at present the most important factor in the total infant mortality.

However difficult this class of cases may be to deal with, the death-rate in institutions for infants is of equal complexity, though seemingly much more simple. The well-known high death-rate among illegitimate babies is responsible in part for the appalling statistics furnished by the foundling asylums. These asylums furnish the greater proportion of the infant mortality in institutions of all classes, and in New York our largest institution of this kind has had a death-rate of 50 per cent. for the past two years, based on births in the institution and admissions under 1 year of age. Hospitals for sick babies also furnish a mortality which seems excessively high. In 1910 the institution death-rate of babies under 1 year of age furnished 42 per cent. of the total in the Borough of Manhattan of New York City.

This condition is being met in part by the boarding out of a proportion of the foundling babies in private homes under the supervision of physicians and nurses of the division of child hygiene. This supervision is neither as far-reaching nor effective as it should be, owing to the institutional rules, but excellent results have been obtained from even this imperfect system. The attempt to raise babies wholesale is a failure, and individual care for them offers the easiest and quickest method of life-saving.

The evolution of the infants' milk stations is essential. Pure milk, however desirable, will never alone solve the infant mortality problem. Under our system of home visiting to instruct mothers in the care of babies, we have demonstrated that babies may be kept under continuous supervision at a cost of sixty cents per month per baby, and the death-rate among babies so cared for by us has been 1.4 per cent. The death-rate among babies under the care of the milk stations has been 2.5 per cent., and the cost two dollars per month per baby. Without overlooking the value of pure milk, I believe that this problem must primarily be solved by educational measures. In other words, that the solution of the problem of infant mortality is 20 per cent. pure milk and 80 per cent. training of the mothers. The infants' milk stations will serve their wider usefulness when they become educational centers for prenatal instruction, the encouragement of breast-feeding and teaching baby hygiene, with the mother instructed to buy the proper grade of milk at the place most convenient to her home.

With these next steps still to be taken, New York City has already demonstrated that infant mortality is a public health problem, that it should and can be effectively dealt with by a properly organized department of health, and that money wisely expended buys public health as readily as it does any commodity. In the largest city, with the most complex population in this country, in a city where poverty and con-

gestion of population are exemplified in their worst form, where immigration furnishes a rushing tide that knows no ebb, and where the resulting economic and social conditions baffle our most advanced students of civic problems, we have demonstrated that the door of hope is open to the littlest of our citizens, and that under the worst conditions it is possible to solve at least a part of the infant mortality problem. Our cities are learning that "it is not the babies that are born, but those that are saved that count."

33 West Ninety-Sixth Street.

# PROGRESS IN PEDIATRICS

## RÉSUMÉ OF WORK ON TUBERCULOSIS IN CHILDREN FOR 1912

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CHICAGO

### MODES OF INFECTION

1. Ghon, A.: The Primary Pulmonary Lesion in Tuberculosis of Childhood. Monograph, Urban and Schwarzenberg, Berlin and Vienna, 1912

2. Calmette, A.: The Portals of Entry and the Diffusion of the Tubercle Bacilli in the Organism. Ann. de méd. et chir. inf. 1912 No. 16, p. 346.

3. Harbitz, F.: The Frequency and Modes of Infection of Tuberculosis in Children. Tuberculosis, 1911, ii, No. 4, p. 173.

4. Dietrich, A.: Congenital Tuberculosis. Berl. klin. Wchnschr., 1912, No. 19, p. 877.

5. Wood, G. B.: Tonsils and Tuberculosis. Pennsylvania Med. Jour. 1912, xv, No. 9, p. 683.

6. Arluck, I. M., and Wincouroff, I. J.: The Question of Infection with Tuberculosis of Jewish Children at Time of Circumcision. Beitr. z. klin. d. Tuberk., 1912, xxii, No. 3, p. 341.

A. Ghon[1] believes the aerogenous is the most frequent mode of infection in pulmonary tuberculosis of childhood, and that the primary lesion is in the lungs and the secondary one in the lymph-nodes. He bases this belief on the autopsy findings of 184 children who died of tuberculosis. In these he found that the pulmonary lesions always showed a more advanced stage of the disease than the glandular and concluded, since the fan-like arrangement of the lesion spread from the pulmonary focus toward the hilus, that the course of the lymphatics was in this direction.

That the hematogenous route of infection does not occur in primary pulmonary tuberculosis is proved by the fact that in 83.53 per cent. of the cases only one lesion was present instead of the multiple lesions which are always found in metastatic processes.

A. Calmette[2] is of the opinion that conceptional infection plays only an unimportant part in the propagation of tuberculosis, and that in the majority of instances infection takes place in infancy and childhood. This is shown by the extreme frequency of positive tuberculin reaction in children from 1 to 15 years of age. In large cities children below 1 year of age become infected in the proportion of 10 to 100. This proportion increases to 50 per 100 in children from 5 to 15 years. The great frequency of tuberculous infection depends on the present social conditions (overcrowding of homes and work-shops, etc.).

The infection can enter through any of the mucous membranes, but the digestive and respiratory are the two most frequent portals of entry. Calmette is a firm believer in the lymphogenous mode of infection. He believes that the bacilli enter the digestive tract, penetrate its mucous membrane without producing any lesions, and then enter the lymphatics and blood-vessels.

In young children this lymphatic and hematogenous infection causes a septicemia (typho-bacillemia of Landouzy). Tubercles form only if the bacilli are not eliminated, but are arrested in the various organs. The disease at this stage may subside and remain latent, when it can be detected only by the tuberculin tests or the tubercles may multiply and become widely disseminated and cause an acute miliary tuberculosis.

Certain individuals are naturally immune or can be rendered artificially incapable of becoming tuberculous, but this immunity is not permanent, and lasts only as long as there are bacilli or latent lesions in the organism. When a tubercle bacillus enters an immunized organism, it acts as a foreign body, but retains its virulence and vitality, and, when eliminated by the various excretory organs, is capable of infecting susceptible individuals.

The virulence of the infection depends on the source of the bacilli, external influences, such as air, light, heat, whether massive doses are received into the organism at long or short intervals, or small doses only once, or frequently; also whether the organism has been infected once before.

A. Dietrich[4] reports a case which suggests the possibility of congenital infection. A woman with general tuberculosis gave birth shortly before her death to a premature infant. Tubercle bacilli were demonstrated in the placenta. The baby was never in contact with the mother. It developed well for the first two months, when an abscess formed in the right groin. Following this there was loss in weight, and râles in the chest. The child died in the third month. Autopsy showed many tubercles in the lungs, intestines and spleen, a few in the liver, and a large lesion in the portal vein.

In instances of congenital tuberculosis, infection takes place in two ways: Either caseated lesions, involving the villi, rupture into the fetal blood-stream, or at birth the tubercles in the placenta are broken up and the particles thus enter the portal blood-vessels.

G. B. Wood[5] discusses the tonsil as a portal of entry of the tubercle bacillus. He says that about 5 per cent. of all tonsils removed, if carefully examined with the microscope, show some tuberculous lesion. He is of the opinion, however, that tuberculous disease of the tonsil only in exceptional cases gives rise to pulmonary disease by way of the lymphatics. In his experimental work, Wood found that, when the glands of the neck

broke down after a tonsillar infection and a pulmonary lesion finally developed, it was always a miliary tuberculosis and was the result of the tubercle bacilli gaining access to the blood channels.

According to I. M. Arluck and I. J. Wincouroff,[6] tuberculous infections of Jewish children in ritual circumcision are not rare in the smaller provinces of Europe. They report a case in point. When seen by the writer, the child was 5½ months old. He was circumcised on the eighth day, and, according to the parents, one of the guests who had a cough sucked the blood from the wound. Two weeks later the penis was red and swollen, then small pussy ulcerations developed. The inguinal glands enlarged and the disease progressed. Examination at the hospital showed a weak, anemic child with enlarged cervical and axillary glands. There was rough breathing over both lungs. The penis to the scrotum was denuded of skin; the glans was divided in its lower half so no external orifice could be found. The entire glans was ulcerated and small ulcers with undermined edges were situated beneath the scrotum. The inguinal glands were very large.

The child died three days after admission. Autopsy showed, beside the tuberculous ulcers of the penis, tuberculous ulcers in the intestine, tubercles in the spleen, caseation of the pelvic lymphatics and mesenteric glands, miliary tuberculosis of the lungs, and tuberculosis of cervical and bronchial glands. The authors believe the lymphatic system, from inguinal and cervical glands, was affected first, and secondarily the lungs, spleen and intestines.

## BACTERIOLOGY

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22. Heymans, J. F.: Tubercle Bacilli in Milk. Ann. d. méd. et chir. inf. 1912, xvi, 12, p. 349.

T. Kurashige, R. Mayeyama and G. Yamada[7] have examined the milk of tuberculous women for tubercle bacilli. They found them as follows: In two women in the third stage of the disease, twice; in five women in the third stage of the disease, five times; and thirteen in the pretubercular or first stage, ten times (76.9 per cent.). In two healthy patients there were no bacilli. In none of the patients was there a tuberculous disease of the mammary gland. Moreover, the authors said that the finding of the tubercle bacilli in the milk corresponded with their presence in the blood and conclude that the bacilli in the milk come from the blood.

C. T. Noeggerath[8] discusses the advisability of tuberculous women or those in whom the disease is suspected, nursing their babies, and describes the experiments he performed to ascertain whether tubercle bacilli are present in the milk of such women. A large quantity of milk, 20 to 50 c.c., was obtained under aseptic conditions and injected subcutaneously and intraperitoneally into guinea-pigs. When feasible, the milk of the same woman was repeatedly examined. Four months after the injection the animals were killed and carefully examined for tuberculous changes. In some instances, Noeggerath injured, at the time of injection, the lymphatic glands nearest the site of injection and at autopsy he studied these especially for tuberculous changes (Block's method). Twenty-six women were under observation and tubercle bacilli were found in the milk of one patient with active, in two with latent tuberculosis, and in one suspected of having the disease. In the milk of another patient suspected of having the disease, a suspicious organism was found. The tubercle bacilli were virulent in two instances and in two their virulence was attenuated. Noeggerath thus concludes that the observation of v. Behring, that tubercle bacilli are secreted in the milk of tuberculous mothers in large enough numbers to be a source of danger to the infant, is incorrect. Nothwithstanding this opinion, Noeggerath protests against tuberculous mothers nursing their infants. He gives the results of his study of statistics bearing on the longevity of infants fed on milk of tuberculous mothers and those fed on artificial foods. They show that the mother's milk neither prevented the infection nor had a favorable influence on one

already present. On the other hand, Noeggerath found that the mortality was lower among infants fed on artificial foods, and, if infection had taken place, the infants lived longer. Nursing, moreover, had an unfavorable effect on the mother; it caused either an extension of an active process or a lighting up of an old latent one. He suggests the establishment of "prophylactic homes" for healthy infants of tuberculous mothers. These must be quite distinct from tubercular sanatoriums for tuberculosis and in charge of a pediatrician.

K. Kennerknecht,[9] examining the blood of 120 children for tubercle bacilli, divided the children into three groups. The first group of sixty-eight were all children in whom tuberculosis had been clinically diagnosed. The bacilli were demonstrated in the blood of all these. The second group of twenty were children in whom tuberculosis was suspected. In eighteen, or 90 per cent., the bacilli were found. The third group, numbering thirty-two, were children admitted to the hospital for other than tuberculous disease. Twenty-three, or 74 per cent., gave positive findings.

The children were simultaneously tested for the v. Pirquet and Moro tuberculin reactions. Of the twenty children suspected of tuberculosis at first six, later, on repetition of the test, five more gave positive reactions. The writer, therefore, concludes that the finding of the bacilli in the blood is of greater value than the cutaneous tests. She says the bacilli occur in the blood in very early stages of tuberculosis, before clinical symptoms are demonstrable.

To prove that the bacilli found were true tubercle bacilli, she injected them into the peritoneum of guinea-pigs. Wide-spread tuberculous changes resulted in the bronchial glands and lungs. The tubercle bacilli were always found in the blood, lungs and bronchial glands, and frequently in other organs, even when there were no pathological findings. This, according to Kennerknecht, speaks for a hematogenous spread of tuberculosis in the organism.

K. Oka[10] examined the blood of forty-nine phthisical patients and thirty-two apparently healthy individuals. Tubercle bacilli were found in 90 per cent. of the former and in 43 per cent. of the latter. These findings agree with those of Kurashige and other observers.

E. Rumpf[11] declares that tubercle bacilli occur more often than was hitherto supposed in the circulating blood of tuberculous and of healthy persons. Delicate bacteriologic technic has disclosed their startling frequency, but inoculation of animals with blood containing the bacilli does not seem to produce tuberculosis in these animals. The writer inoculated thirty-five guinea-pigs with blood from several patients suffering from advanced tuberculosis, from several with the disease in the incipient stage, and from three clinically healthy physicians. Only three of the

animals developed tuberculosis. Rumpf suggests three explanations: The bacilli were not tubercle bacilli, or were not viable, or the blood into which they were injected protected the inoculated animals. In other experiments, where the bacilli were cultivated in pure cultures from the blood and the animals inoculated with the cultures, tuberculosis was produced in the inoculated animals. Rumpf is very much puzzled over this finding of tubercle bacilli in the blood of healthy as well as tuberculous individuals.

M. Piery[12] was able to demonstrate tubercle bacilli in the sweat of patients with open and of those with closed tuberculosis. The sweat was obtained by giving the patients electric baths and was then inoculated into guinea-pigs. The proof of the contagious nature of the sweat shows the necessity of greater prophylactic measures in regard to this secretion. Disinfection of all clothes, linens, etc., coming in contact with the patient must be complete. Separate beds must always be provided for patients even with closed tuberculosis.

P. Nobécourt[13] outlines his results in searching for tubercle bacilli in the various tissues and organs, as a means of substantiating a diagnosis of tuberculosis.

He says that tuberculosis of the skin is often difficult to diagnose from syphilis, and whenever microscopical and cultural results are negative, animal experimentation should be resorted to. Tubercle bacilli are frequently found in ulcerative tuberculides, tuberculous gummata and verrucose tuberculides, rarely in lichen scrofulosorum, the papular necrotic tuberculides and erythema induratum.

The finding of tubercle bacilli in "throat smears" is difficult and a negative result is always of doubtful value.

In enlarged tonsils the bacilli are frequently found and are of great diagnostic interest.

Microscopical examinations of the peripheral glands are almost always negative, but animal inoculations are positive.

Animal experiments in tuberculosis of the bones, joints and ligaments are very unsatisfactory. The bacilli, when found, have been shown to be less virulent than in other forms of tuberculosis, but if they are found, their presence is a great aid in differentiating atypical forms of tubercular osteomyelitis from lues and actinomycosis and in determining the nature of certain forms of chronic rheumatism.

The idea that most cases of serofibrinous pleurisy are of tuberculous nature is not shared by all observers. A number of inoculations must be made with a large quantity of fluid before a negative result is determined. In the purulent forms of pleurisy bacteria other than the tubercle bacilli are the most important and it is usually difficult to determine whether

the tubercle bacilli are present. Animal inoculation is the only method. Hemorrhagic pleurisy is rarely of tuberculous origin.

What was said of pleural exudates is true of peritoneal. A diagnosis of tuberculosis must be made with great care and only after repeated inoculations.

The finding of tubercle bacilli in the lumbar fluid is a matter of great difficulty. Sometimes only after examining slides for hours is the search successful. The frequency of positive results varies with different writers. Cultural and inoculation experiments, however, give very satisfactory results.

Repeated examinations are necessary in the search for tubercle bacilli in the urine and they are not always found even when there is a tuberculosis of the kidney, because of a blocking up of the ureter of the diseased kidney. Tubercle bacilli may be present in the urine of children without any evidence of disease of the urinary tract.

Tubercle bacilli have been demonstrated in the blood of children by obtaining the blood with leeches and then injecting it into guinea-pigs. In four of thirty-two tuberculous children the writer found the tubercle bacilli.

Discussing the relative importance of the tubercle bacillis of human and bovine origin in infection of man, A. Calmette[14] quotes the points established by the English Royal Commission on Tuberculosis:

1. There is no morphological difference which allows of a constant differentiation between the bacilli of human and bovine origin.

2. Culture methods are useful, but not accurate enough to allow of positive differentiation.

3. Inoculation of various animals is the best method. In most cases the human tubercle bacilli will not produce an infection when inoculated into rabbits. If 1/100 mg. of bovine bacilli is introduced into rabbits, the animal shows a general infection in from four to eight weeks. It is therefore incontestable that the bovine tubercle bacilli is more virulent than the human.

4. Experiments performed with the end in view of so increasing the virulence of the human type as to make the bacilli capable of producing wide-spread tuberculosis in cattle and rabbits have so far been unsuccessful. Certain bacilli, however, of the human type are capable of adapting themselves to the organism of cattle and such organisms are then virulent to cattle and show cultural characteristics of the bovine bacillus (Ebers).

5. Human beings, especially children, can become infected with the bovine bacillus. It frequently happens that at autopsies of children who are the victims of acute tuberculosis, this bacillus is found in the glands or elsewhere.

6. It is an undeniable fact, however, that even among children 75 per cent. and among adults 98 per cent. of the deaths are caused by the human tubercle bacillus.

From the foregoing Calmette deduces that, while protective measures against a possible bovine infection must not be omitted, care must be taken to prevent contagion of man from man, especially in the family.

In a very instructive paper on bovine and human tuberculosis, J. Orth[15] reviews the work which has already been done on this important subject. He believes that there are two types of tubercle bacilli, one peculiar to man and one to cattle. These two types have not fixed, non-interchangeable characteristics, but are two independent organisms. Typical human bacilli are not pathogenic to cattle, but typical bovine bacilli are pathogenic to man. Bovine tuberculosis appears especially, but not exclusively, in children, and though it is true that the changes usually produced in man by the bovine bacillus are slight and non-virulent, many virulent, fatal cases due to this type have been reported. Most cases of pulmonary tuberculosis are caused by the human bacillus, but not invariably. A bovine infection in childhood may be the source of a phthisis in later life, and although the human bacillus should first be combated, the bovine type must not be disregarded.

The work for the future is evident. The distinction between the two types of bacilli must be studied; atypical forms must be investigated; attempts must be made to change the bovine into the human type of bacillus. The frequency of bovine infection in children must be determined, and material must be collected to solve the question whether bovine infection in children leads to phthisis later in life; and how the bovine bacillus enters the human organism must be discovered.

M. P. Ravenel,[16] summarizing the statistics of various authors, found that of 787 adults, 777 showed infection with the human type of bacillus, and ten with the bovine type; in children 5 to 10 years of age, of 153 cases, 117 showed the human, and thirty-six the bovine type; of 280 cases below 5 years, 215 showed the human, and sixty-five the bovine type. Considering these figures, Ravenel does not see how anyone can deny the danger to children of bovine tuberculosis.

E. Tomarkin and S. Peschic[20] were able to differentiate the human from the bovine type of bacillus by cutaneous vaccination of guinea-pigs. Pure cultures of both types of bacilli and products of diseased organs, as sputum, urine, etc., containing the bacilli, were rubbed into the shaved skin on the abdomen of the animals. Of fifty-two guinea-pigs vaccinated with the human bacilli only seven became tuberculous. All animals vaccinated with the bovine bacillus, without exception, suffered first from a glandular then from a general tuberculosis. In none of the animals were local manifestations observed.

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The results are accounted for by a difference in virulence for guinea-pigs of the two types of bacilli.

L. Panisset[21] says that 10 per cent. of commercial milk contains virulent tubercle bacilli, as do also milk derivatives, like butter, cheese, buttermilk, etc. The bacilli usually come from a tuberculous lesion of the udder or from the excrements which fall into the milk at the time of milking. Exceptionally, milk from cows which give a negative tuberculin reaction, contains tubercle bacilli. Milk from a healthy cow, too, can become contaminated from infected surroundings.

The bacilli in milk retain their virulence for a long time, and though the digestive system plays only an unimportant rôle as a portal of entry for the infection, tuberculous milk must be considered dangerous to man. This danger is greater for children, especially for young infants, and is increased if consumption of the milk continues for a long time.

As prophylactic measures, Panisset advised inspection of dairies, so that milk will be furnished from non-tuberculous, healthy cows. He says that pasteurization of milk is of value only when under official control.

J. H. Heymans[22] says that milk can become contaminated with human bacilli if handled by persons with open tuberculosis, with bovine bacilli from cows with mammary tuberculosis or with an open tuberculosis of other organs (fecal excretions falling into the milk). In a dairy if one cow excretes tubercle bacilli it is enough to infect the milk of all.

DIAGNOSIS

23. Petruschky, J.: The Specific Diagnosis and Therapy of Tuberculosis. Ergeb. d. inn. Med. u. Kinderh., 1912, ix, 557.

24. Monti, R.: The Diagnostic Value of the Intracutaneous Tuberculin Test. Wien. med. Wchnschr., 1912, lxii, 7, p. 147.

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28. McNeil, C.: Tuberculous Infection in Infancy and Childhood as Revealed by the Cutaneous Tuberculin Test. Edinburgh Med. Jour. 1912, viii, 4, 324.

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35. Editorial: Why Does the Tuberculin Reaction Disappear in the Acute Infectious Diseases? Jour. Am. Med. Assn., 1912, lix, 5, p. 373.

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J. Petruschky[23] has exhaustively reviewed the methods of treatment and diagnosis of tuberculosis. He says that the cutaneous test has so many advantages over other diagnostic methods that most clinicians have exclusively adopted it. He performs the test as follows: With an ordinary vaccination lancet he makes on the skin of the arm two lines (==) or crosses (X X), one of which he touches with a drop of tuberculin. If positive, the reaction occurs in three grades.

1. Redness of the edges of the scratch; (2) localized red area around the vaccination site; (3) vesicles on the scratch marks with a raised red area surrounding them.

If the cutaneous reaction is negative, he repeats the test a second time, and, if this is negative, regards the result as final. If the reaction is really negative, the test can be frequently repeated, but will never produce a positive reaction. Reactions which are questionably positive become more marked on second vaccination and can be regarded as positive.

With very small or restless children Petruschky uses the Moro test. He avoids the Koch subcutaneous injection method, unless there is especial reason for its use, as the supposition is well founded that in forcing a reaction for diagnostic purposes an old, inactive lesion may be awakened. He emphasizes the point, however, that it is not necessarily harmful to excite the old lesion. He cites a number of instances in which the reaction was followed by an increase in well being without deleterious effects.

When patients have been treated with tuberculin, the specific diagnostic methods are of value to determine whether cure has been established, but cannot be used until a number of months after the cure is effected. As a rule, the cutaneous reaction remains positive for a long time, even with a relative non-sensitiveness to the subcutaneous injections, and it is only after repeated tests in resolving cases that the reaction becomes less marked and finally negative.

Petruschky does not regard either conjunctival or the inhalation tests as safe procedures and advises against them. The intracutaneous test has the same value as the subcutaneous, but is more difficult to use and is painful.

R. Monti[24] experimented with the intracutaneous tuberculin test in order to compare its sensitiveness with the cutaneous. The intracutaneous test consists of injecting small amounts of diluted tuberculin into the upper layers of the skin, when, if positive, a redness and swelling appear at the point of injection.

The author divided his cases into two groups. The first included fifty-eight children with clinically manifest tuberculosis. These reacted in the same way to both tests, so in this form of the disease one test has no advantage over the other. The second group consisted of 316 children who clinically were considered free of tuberculosis or only suspicious. All the cases which reacted to the cutaneous test reacted also to the intracutaneous; besides, twenty-nine cases with a negative cutaneous gave a positive intracutaneous reaction. Hence, in latent forms of tuberculosis, the intracutaneous test is more sensitive.

Monti also repeated on children the experiments which Römer and Joseph performed on guinea-pigs. These writers were able to judge the prognosis of the disease by the degree of intracutaneous reaction obtained with a known amount of tuberculin. In these tests Monti took children who were sensitive to tuberculin and injected them simultaneously with three tuberculin solutions, 1-1,000,000, 1-100,000 and 1-10,000. The reactions were no different in children with latent tuberculosis or with active lesions; so the Römer-Joseph method is of no value in children.

Combe[25] has also experimented with the intracutaneous tuberculin test and found it more sensitive than the cutaneous. To avoid errors in judging the value of results, the following points must be borne in mind. The reaction is negative, when no antibodies have yet been formed, as within three weeks of infection; if cachexia prevents the further formation of antibodies, if the antibodies are absorbed, as in miliary tuberculosis and tuberculous meningitis, at the time of intercurrent infections, like measles, typhoid, whooping cough and influenza.

The intracutaneous reaction is of value in judging the results of tuberculin treatment. The reaction should be repeated every fourteen days, and, if it gradually subsides, good results can be expected from the treatment. If, however, it again becomes strongly positive when the dose of tuberculin is diminished, the treatment should be stopped.

C. McNeil[28] performed the cutaneous tuberculin test on 541 children, ranging in age from a few weeks to 15 years. The maximum number of positive reactions occurred during the fourth and fifth year, before the period of school life.

The writer states that abdominal tuberculosis is, in large part, at least, a bovine infection. It is from nine to ten times more frequent in Edinburgh and Glasgow than in New York and Boston. In 330 cases the cutaneous test was made with both the bovine and human tuberculin, but it did not offer a means of distinguishing between the two types.

F. L. Wachenheim[29] believes that the value of the cutaneous tuberculin test has been underrated and that the significance of a positive

reaction is nearly as great in later childhood as in infancy. The writer's investigations include fifty cases which fall into two groups. The first group of thirteen gave clinical evidence of tuberculosis. All had positive reactions. The second group included children who were physically below normal, but who did not show any signs of tuberculosis. Only two had positive reactions. Wachenheim concludes that if 95 per cent. of all run-down children give a negative reaction, a positive one in the small remainder is highly significant, and should be regarded seriously. An energetic antituberculous prophylaxis should be promptly initiated and the child guarded against the disease.

W. C. White and H. H. Van Norman[31] have attempted to obtain a specific biologic test for the therapeutic dose of tuberculin. Such a test, they believed, would get rid of the tedious method of starting all patients on an exceedingly small dose and gradually working up over a period of many months to a dose which bordered on a reaction or which produced a tolerance.

The method was to find the dilution of tuberculin, which, with a given technic, would give a minimal cutaneous reaction, and then to determine the quantity of tuberculin which could be given subcutaneously to produce a reaction of required degree.

By a minimal cutaneous reaction they designate one which within seventy-two hours measures 4 mm. in diameter and shows some induration.

A spot 2 mm. they scarified on the inner side of the forearm and applied with a throttle pipet 0.01 c.c. of a 1 per cent. tuberculin. Readings were taken at the end of twenty-four, forty-eight and seventy-two hours. If at the end of seventy-two hours this amount gives the minimal cutaneous reaction, it is unnecessary to test further; if there is no reaction, a 2 per cent. solution is used. If a 1 per cent. causes a larger than minimal cutaneous reaction, a half or quarter per cent. should be used, until the minimal cutaneous reaction is obtained. A week should always be allowed to elapse between tests.

The authors have found that the quantity of tuberculin contained in 0.01 c.c. of the solution which will produce the minimal cutaneous reaction will produce, when given subcutaneously, an area of redness, tenderness and swelling that measures 2 to 5 mm. in diameter. For example, a patient showing a minimal cutaneous reaction to 0.01 c.c. of a 1 per cent. solution of tuberculin has 0.10 mg. of tuberculin applied to the skin. The therapeutic dose of this patient would be 0.10 mg.; this dose given subcutaneously will cause a local reaction of 2 to 5 cm. in forty-eight hours.

By this method, then, it is possible to determine a dose of tuberculin which will produce in every patient the same degree of local reaction, and

will allow the determination of a perfectly safe dose, varying at least 100 times in quantity. The administration of tuberculin in doses which produce these mild local reactions has given the best results of any methods of tuberculin the authors have used.

E. C. Moreland[32] describes a quantitive cutaneous tuberculin test which he calls the quanti-Pirquet test. He uses four dilutions of old tuberculin, 64, 16, 4 and 1 per cent. Four circular holes are drilled in the skin of the forearm until the base shows a vivid pink, but does not actually bleed. A drop of one of the tuberculin solutions is applied to each scarification, the weakest solution to the one nearest the hand. The excess of fluid is sopped up with tiny pieces of sterile wool and the moist spots left to dry for four minutes.

The diameters of the resulting papules is measured in millimeters after twenty-four and forty-eight hours. Only the papule is measured, not the surrounding zone of hyperemia, and the diameter of the scarification is subtracted. The figures are charted, the average size estimated and compared with a table of standards. Thus if the papula is five and one-half, it corresponds in the table to a sensitiveness value of 130 expressed thus: Q — P. = 130.

The method is of value in deciding the question whether the existent tuberculosis requires treatment, as a guide to the progress of the case, in diagnosing the presence of the disease, in determining the initial dose and in standardizing any particular preparation of tuberculin.

W. J. Moltschanoff[33] performed the von Pirquet tuberculin test on 150 children suffering from the various infectious diseases. In all cases of measles the reaction was negative during the eruptive stage, but became positive when the eruption faded. In 84 per cent. of the scarlet-fever patients there was no reaction to this test and in 15 per cent. a very weak one. In 12 per cent. of those with diphtheria it was negative and in 5 per cent. weak; in diphtheria it disappears much less frequently than in measles or scarlet fever.

The author believes the disappearance of the tuberculin reaction in the acute infections is due to changes in the skin. He says that the skin is the organ, the sensitive plate, as it were, on which we observe the reaction of the organism to tuberculin and that the altered skin is not capable of showing the reaction, whether the organism contains tuberculous immune bodies or not.

Paisseau and Tixier[34] found that the *"stich-reaction"* was less pronounced during the acute infectious diseases as typhoid pneumonia, pertussis, and cerebrospinal meningitis. There was no rule as to the time when this diminution in the reaction appears. Sometimes the reaction was absent during the febrile stage of the disease and reappeared only when convalescence was established. Sometimes the reverse was noted.

The author noticed also that the reaction sometimes disappeared in such chronic affections as chronic appendicitis and brain tumor, and became positive again only after many months.

An editorial[35] in *The Journal of the American Medical Association* attempts to explain the disappearance of the v. Pirquet reaction in the various acute infectious diseases. V. Pirquet suggests that it is due to a failure of the body when attacked by a new infection to produce the specific antibodies in sufficient quantity for a reaction. Other writers believe there is a relation between the disappearance of the reaction and the leukopenia of measles. Still others believe it depends on changes in the skin itself. This explanation might seem applicable to measles, scarlet fever, and possibly to serum disease, but not to pneumonia, diphtheria or typhoid.

The editor gives us still another explanation, that it is due to an anti-anaphylaxis. In all these infectious diseases the body is in an anaphylactic state, due to the introduction of foreign proteins of various kinds, and it is known from experiments on animals that as recovery from this anaphylactic state takes place there develops a condition of insusceptibility to further intoxication, called anti-anaphylaxis.

If this explanation holds good, it would be expected that other reactions would fail also in the acute infectious diseases, and it is interesting to note that Hamburger has found a complete insusceptibility to vaccination in measles.

In discussing the diagnosis of tuberculosis in children, W. C. Hollopeter[36] lays stress on the family and previous history. The history of tuberculosis in the family of a sick child is almost *a priori* evidence of some form of tuberculosis. Careful and tactful questioning is often necessary before the source of human contagion is established. Other matters of importance to be noted in the anamnesis are the various predisposing causes of the disease. They include unhygienic surroundings, improper feeding, and the various children's diseases.

The importance of diagnosing bronchial gland tuberculosis has developed special methods and alleged signs. Pressure on the veins, dulness over the first bone of the sternum, the paroxysmal cough point conclusively to caseation of the bronchial glands. The cough is distinguished from that of pertussis by the absence of crowing, of the terminal vomiting, and of the expectoration of glairy mucus.

Before enlargement has become great enough to cause symptoms, assistance may be gained from the following experiment. If the child be made to bend back his head so that his face becomes almost horizontal and the eyes look straight at the ceiling above him, a venous hum is heard over the upper border of the sternum. As the chin is slowly depressed, the hum becomes less audible and ceases shortly before the head reaches its ordinary position.

The early diagnosis of tuberculous mesenteric glands is a matter of great difficulty. To ascertain enlargement of the abdominal glands Hollepeter places the child in the knee-chest position or on the back with the knees well flexed and the head well curved on the chest.

The *x*-ray is an important aid in diagnosis; the temperature is less significant in children than in adults. Holt's method of obtaining sputum by irritating the pharynx with a small bit of muslin in the jaws of an artery clamp is of value, and tubercle bacilli are often detected, but in most cases repeated examinations are necessary.

The cutaneous tuberculin test has grown in favor and is widely employed. As latent tuberculosis is rare in infants, a positive reaction is a warning to be heeded. The Wolff-Eisner opththalmic test has become unpopular, as many serious injuries of the eye have been reported.

Moro's percutaneous test is less sensitive than the cutaneous test, and latent tuberculosis does not so often give reactions. Hollopeter says it is to be selected both for ease of application and certainty of results, although he states that Hamburger believes the *"stich-reaction"* to be more reliable.

Hollopeter calls attention to the tuberculides, first described by Hamburger, as a means of diagnosis. They are small, slightly raised, round papules, red in color at first, later brownish. The crest is covered with a scale which can easily be scraped off and leaves a small crater-like depression in the center. Hamburger found these tuberculides in nearly all his cases of tuberculosis in infants.

E. Sluka[37] finds the *x*-ray a valuable aid to diagnosis in children whose lungs show no physical findings but whose history (loss of appetite, fatigue, evening rise in temperature, dry irritating cough) awakens the suspicion of tuberculosis. A broad hilus shadow made up of circumscribed darker areas speaks for enlarged caseated glands. A uniformly dark shadow which merges into the lungs as smaller areas of shadow speaks for a pulmonary lesion.

SYMPTOMATOLOGY

38. Dossin, M.: Tuberculosis in Infancy. Le Scalpel et Liege méd., 1912, xliv, 703.

39. Hamburger, F.: Late Forms of Tuberculosis. München. med. Wchnschr., 1912, lix, 12, p. 631.

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41. Sawyer, J. E. H.: Frequency of Consumption in Children. Birmingham Med. Rev., 1912, xix, 57.

42. Hutchinson, W.: A Study of Tuberculosis in Children. Brit. Jour. of Tuberculosis, 1912, vi, 19.

43. Ager, L.: Intrathoracic Tuberculosis in Children. Am. Jour. Obst., 1912, lxv, 335.

44. Halipré, M. A.: Sudden Death of an Infant Due to Rupture of a Caseated Lymphatic Gland Into the Trachea. Ann. d. méd. et chir. inf., 1912, xvi, 8, 241.

45. Cacciani, I.: Sudden Death from Tuberculous Tracheo-Bronchial Adenopathy. Abst. Brit. Jour. Child. Dis., 1912, ix, 106, p. 464.

46. Pfeiffer, T.: Tuberculosis of the Bronchial Lymph-Glands. Wien. med. Wchnschr., 1912, xv, 62, 965.

47. Friedjung, K.: Tuberculosis of the Bronchial Glands and Tumor of the Brain. Ztschr. f. Kinderh. (Ref.), 1912, iii, 2 and 3, 79.

48. Corner, E. M.: Tuberculosis of the Mesenteric Glands in Children. Lancet, London, 1912, i, 7, 426.

49. Schram, C.: Primary Tuberculosis of the Mesenteric Glands. Am. Jour. Surg., 1912, xxvi, 7, 269.

50. Talbot, F. B.: Tuberculosis of the Mesenteric Glands in Infants and Young Children. Am. Jour. Child. Dis., 1912, iv, 1, 49.

51. Schloessman, H.: A Clinical and Pathological Study of Primary Mesenteric Tuberculosis. Beitr. z. klin. Chir., 1912, lxxviii, 2, 241.

52. Arbeiter: Studies of Frequency of Primary Intestinal Tuberculosis. Abs. Monatschr. f. Kinderh., 1912, xi, 3, 171.

53. Meara, F. S., and Goodridge, M.: Relationship Between Erythema Nodosum and Tuberculosis. Am. Jour. Med. Sc., 1912, cxliii, 3, 393.

54. Sézary, A.: Erythema Nodosum and Tuberculous Meningitis. Gaz. d. hôp., 1912, 85, 125.

55. Kober: Tuberculosis and Erythema Nodosum. Med. Klin., 1912, viii, 19, p. 781.

56. Powell, R. D.: Fatal Hemoptysis in Early Life. Lancet, London, 1912, i, 5, p. 321.

57. Januschke, H.: General Tubercular Eruption after Measles. Ztschr. f. Kinderh., 1912, iii, 1 and 2, p. 80.

58. Barbier, H. and Gougelet, G.: Curable Tuberculous Meningitis. Arch. d. méd. d. enf. 1912, xv, 4, p. 241.

59. Hochstetter: Case of Recovery from Tuberculous Meningitis. Deutsch. med. Wchnschr., 1912, xxxviii, 12, p. 554.

60. Vignard, P. and Thievenot, L.: Renal Tuberculosis in Childhood. Jour. d. urol. et chir., 1912, i, 323.

M. Dossin[38] states that generalized tuberculosis is the rule in children, as the organism does not resist the infection and allows it to diffuse rapidly. He distinguishes two forms, the acute tuberculous fever of Landouzy and a chronic diffuse form. The first causes death before marked localization of the disease. The second gives rise to two clinical pictures, that of an athrepsia or of a bronchopneumonia. Children with tuberculous athrepsia have excellent appetites and digestions, and show no rise of temperature. The patient becomes pale and more and more emaciated, until there is no adipose tissue and the skin is stretched tightly over the bones. The eyes are sunken, the eye lashes long, the hairs between the shoulder-blades and on the extremities are abundant. Sometimes digestive disorders set in and are due to tuberculous ulceration of the intestine. The child usually dies of a septicemia.

Tuberculous bronchopneumonia usually affects the base of the lungs, where are found areas of bronchial breathing and râles. These areas clear up and others develop. In the interval the general condition remains poor. The fever oscillates and the child becomes cachectic. Recovery is rare.

F. Hamburger[39] does not believe that the only resemblance between tuberculosis and syphilis is that both are chronic infectious diseases. In both diseases there is a primary lesion with enlargement of the regional lymphatic glands, an immunity against new infections and a tendency to recurrences or exacerbations. Also as with syphilis one can divide tuberculosis in three stages, primary, secondary and tertiary, but Hamburger thinks a division into early and late forms a more practical one. By late forms Hamburger means those which develop years after the infection has taken place. Phthisis belongs to the late stage because, as is well known, pulmonary tuberculosis is the result of an infection which took place during childhood.

Tumor albus and tuberculosis of the joints and tendons are also late forms of the disease. These occur in older children and are manifestations of an endogenous infection which probably occurred about the fifth or sixth year and which at that time did not give rise to any apparent lesion. To the late forms also belong tuberculosis of the kidneys, lupus vulgaris, chronic tuberculous iritis, tuberculous cirrhosis of the liver, adhesive pleuritis and pericarditis.

G. G. Wilson[40] also compares the clinical course of tuberculosis in children with that of syphilis. The primary stage does not offer a clear picture, but shows such symptoms as remittent fever, emaciation, metallic cough, often due to pressure of enlarged bronchial glands, and dyspnea.

As secondary lesions would be classed skin eruptions (tuberculides) bone lesions, tuberculous meningitis, pleurisy, peritonitis. The tertiary stage is that of chronic infiltration and breaking down of lung tissue.

J. E. H. Sawyer[41] says that "consumption" as it occurs in adults is the rarest of all affections of childhood. Tuberculosis of the lungs in childhood is either a tuberculous bronchopneumonia or part of a generalized infection. Different interpretations are put on such signs as tubular breathing at one apex or impairment of resonance. In debilitated and rachitic children there are observed transient areas of dulness due to certain portions of the lungs not acting to their full extent, because of a bronchus being plugged with secretion. Much of the supposed consumption is a chronic bronchial catarrh, due to enlarged tonsils and adenoids, or a mild form of bronchiectasis, which is common after whooping-cough.

W. Hutchinson[42] sums up his views on tuberculosis in children as follows: The frequency of pulmonary tuberculosis in children is much greater than was formerly supposed. In fact, as among adults, the lung is the most frequent site of the process—whatever the portal of entry may be. Tuberculosis of the bones, joints and glands is secondary to the pulmonary disease and represents a residual stage of a generalized infection.

The degree of immunity which children who have osseous or glandular tuberculosis seem to possess against pulmonary tuberculosis may be explained by the fact that they have already survived a considerable degree of pulmonary involvement.

M. A. Halipré[44] reports the sudden death of unusual character of a child 8 years old. It was due to the rupture of a lymphatic gland into the trachea. On the child's entrance to the hospital there was dulness over half the thorax with moderate dyspnea and elevated temperature. Puncture revealed a yellowish-green opaque fluid, and 20 c.c. were evacuated. After removal of the fluid the general condition improved but dulness persisted in the apex of the right lung and at the base. Suddenly, after ten days of normal temperature, the child sat up in bed, screamed and fell over dead.

Autopsy showed a caseous, tubercular bronchopneumonia of the right lung, on the internal surface of which was a chain of enlarged caseated glands. The trachea was occluded in its lower third by a caseated mass and its removal revealed an ulcer which led into an excavated lymph-gland. Death had evidently been caused by the rupture of this gland. All the viscera showed miliary tubercles.

I. Cacciani[45] records the sudden death from tuberculous tracheobronchial adenopathy of a 3-year-old boy. He was admitted to the hospital for bronchitis and ten days afterward was seized with violent dyspnea and cyanosis. The pulse became imperceptible and death occurred immediately. Autopsy showed a diffuse tuberculosis of glands, lungs and spleen.

T. Pfeiffer[46] says clinical and anatomical observations prove that tuberculous infection in childhood takes place through the lymphatics—especially through the tracheobronchial glands. He has found parasternal and paravertebral dulness of more value in diagnosing hilus-gland enlargement than dulness directly over the spinal column. The *x*-ray is also of great value.

Characteristic symptoms are a high pitched metallic cough, an expiratory crow, unilateral or bilateral dilatation of the thoracic veins, venous stasis over the manubrium when the head is thrown back and inequality of pupils. Enlarged lateral thoracic and suprathoracic glands may indicate enlarged bronchial glands. The tuberculosis tests are of value as aids to diagnosis.

K. Friedjung[47] reports a case of brain tumor complicating a bronchial gland tuberculosis. The patient, 5 months old, had been coughing for five weeks. It had become pale and emaciated and had had typical signs of bronchial gland tuberculosis (metallic cough, expiratory crow, exophthalmos). One week before the child was admitted to the hospital, numerous tuberculides and a strabismus of the left eye developed (paralysis of the

superior rectus and inferior oblique muscles) as well as paralysis of the left facial nerve.

Friedjung thinks that there was a metastasis through the blood-stream into the brain.

E. M. Corner[48] finds that the frequency of tuberculosis of the mesenteric glands in children dying from some form of tuberculosis varies from 54 to 78 per cent. and in 22 per cent. the lesions in the mesenteric glands were the only ones present.

The author has been surprised at the frequency with which tuberculous mesenteric glands are found at abdominal operations on children. In his experience tuberculous mesenteric glands and a dilated appendix containing fecal matter, but not obviously diseased, were always found in children on whom an exploratory abdominal operation was performed for vague abdominal symptoms. He believes the appendix is the portal of entry of the tubercle bacilli and explains it by the temporary arrest of the fecal matter and the rapid multiplication of bacteria at this point.

He advises removal of the appendix as the first step in the treatment of this condition.

C. Schram[49] says that the recognition of primary tuberculosis of the mesenteric glands is not so general as it should be, in consideration of its frequent discovery at autopsy. It is more common in children, and the possibility of infection through the milk and the importance of a pure milk-supply must be dwelt on.

The disease may remain latent for months or years and then give rise to tuberculosis in any part of the body. Obscure abdominal pain, associated with digestive disturbances and rapid loss of flesh, are indicative of the condition which should be carefully sought in laparotomies for appendicitis or intestinal disorders.

F. B. Talbot[50] has found an excess of fat in the stools of children suffering from tuberculosis of the mesenteric glands and also cites from the literature a number of cases with the same finding. He believes that the disease so interferes with the function of the glands, that they can no longer absorb the fats which are dammed back into the intestine and appear in the stools.

He therefore feels that the diet of these children should be regulated according to the stool-findings and if fat is present in excess, fat should be removed from the food and the caloric needs supplied by carbohydrate and protein.

H. Schloessman[51] states that lately the attention of the surgeon has been more frequently called to isolated primary tuberculosis of the mesenteric glands. He reports two cases which came under his notice. The first was a boy of 16 in whom the disease took the form of a rather acute intestinal obstruction. Operation revealed a tuberculosis of the mesen-

teric glands with adhesions of mesentery and omentum which caused a kinking of the intestine and symptoms of ileus.

The second case was that of 14-year-old girl. There had been pain in the right lower part of the abdomen with fever and vomiting. A mass could be felt which resembled an appendicular exudate. Operation revealed a tuberculosis of the glands at the root of the mesentery.

Schloessman quotes Orth and Rabinowitch, who believe that tubercle bacilli can pass through the intestinal wall without giving rise to pathological changes, and also Baumgarten, who believes that the bacilli enter the blood-stream and then locate in the lymphatic glands. Schloessman thinks this theory is not consistent with the frequent autopsy findings of an isolated tuberculosis of the mesenteric glands, for, if the bacilli enter the blood-stream, lesions would be found elsewhere in the body. To show that in all probability the tubercle bacilli pass through the uninjured intestinal wall, he cites a third case. A girl of 25 suffered for three months with pain and a tumor in the right side of the abdomen. At operation a mass of tubercular glands was found adherent to the ascending colon. There was no evidence of tuberculosis in the resected intestine and four and one-half years later she was in good health.

In studying the records of the Rotterdam Hospital Arbeiter[52] found intestinal tuberculosis most common in children between 1 and 15 years of age. There were no cases below 1 year. This he explains by the great tendency to general infection in tuberculosis of infants. Even when infection is through the intestines, general infection takes place before a lesion develops in the intestines. He draws the following conclusions from his study: Primary tuberculosis of the intestines and mesenteric glands is not so rare as is affirmed by many writers. The great rarity among infants, however, can be explained by the virulence of the tuberculous process and the tendency to general infection. The possibility of the intestine being the portal of entrance of the infection in infants is not excluded by the rarity of an intestinal or mesenteric tuberculosis.

F. S. Meara and M. Goodridge[53] discuss the various recent reports and experiments which go to prove a relationship between erythema nodosum and tuberculosis. Among those quoted at length is the thesis of Mlle. Péral, which is a report of twenty-two cases. In several of her cases the erythema nodosum was associated with a tuberculous meningitis.

The writers themselves report an interesting case of erythema nodosum which occurred as an early manifestation of tuberculous meningitis. The patient was an Italian woman of the age of 25, who was admitted to the hospital with a well-marked erythema multiforme on the face and extremities, accompanied by an erythema nodosum. The skin lesions subsided but the woman ran an intermittent temperature varying from 99 to 100 F. In the fifth week an area of dulness with prolonged high

pitched expiration, bronchial voice sounds, and moist râles was found at the base of the right lung. Symptoms of meningitis developed and the patient died six weeks after entering the hospital. Autopsy showed tuberculous lymphadenitis of the cervical and mediastinal glands; tuberculous bronchitis; localized miliary tuberculosis of right lung, and tuberculous meningitis.

A. Sézary[54] observed a tuberculous meningitis develop in a girl of 8 years, four months after an attack of erythema nodosum. As this association has frequently been observed, the writer believes that children who have suffered from erythema nodosum should be regarded as suspicious of tuberculosis and treated accordingly.

Kober[55] reports an interesting case of erythema nodosum associated with a hilus tuberculosis. The patient was a 6-year-old child who ran an afternoon temperature of 39.1 C. for two weeks. He had had several similar attacks. Suddenly an erythema nodosum appeared, first on the anterior surface of the tibias, then on the abdomen and fore-arms. A few years before, the child's father had suffered from an exudative pleuritis and there were two deaths from tuberculosis in the immediate family. *X*-ray picture of the child's thorax showed an enlargement of the bronchial lymph-glands and their tuberculous nature was confirmed by a positive v. Pirquet reaction. Kober also emphasizes the importance of instituting prophylactic measures against tuberculosis in all cases of erythema nodosum.

R. D. Powell[56] reports a case of fatal hemoptysis in a 7-month-old child. The child had coughed from December to April and presented signs of tuberculosis. On April 1 he suddenly expectorated half a pint of dark, partly clotted blood and expired almost instantly.

On post mortem the lungs were found strewn with miliary tubercles and at the base of the left lung was a ragged cavity traversed by trabeculae containing blood-vessels still patent. Near the apex of the same lung was another small cavity across which stretched a vessel one-tenth of an inch in diameter. Its walls were thickened and at one point the wall was eroded and had given way. The vessel was one of the larger branches of the pulmonary artery.

Januschke[57] reports the following: A 3-year-old tuberculous child developed measles. Two months later there was a rapid increase in all the tuberculous findings in the lungs. Then a papulosquamous tuberculide appeared on the skin. The lesions were 2 to 6 mm. in diameter and were especially numerous on the thighs, buttocks and lower extremities.

H. Barbier and G. Gougelet[58] apply the term curable meningitis to certain transient meningeal attacks which occur in children suspected of tuberculosis. They have found reports in the literature of a number

of these cases of so-called curable meningitis, and classify them as follows: Cases with long periods of subsidence of symptoms; cases of complete recovery in which the diagnosis was confirmed by lumbar puncture and inoculation experiments; cases with two or three successive attacks of meningitis and intervals of apparent health.

The meningeal attack may be manifested solely by a zona or pain in the course of the peripheral nerves, or there may be the usual symptoms of a meningitis. If a diagnosis is not made, it is because in diagnosing meningitis one has always in mind the usual meningeal syndrome with a fatal outcome.

Although the acute symptoms are transient and recovery ensues, the meningeal exudate may cause sequelae, as paralysis of the eye, face or extremities, disorders of gait, aphasia or inequality of the pupils, and it is possible, according to the writers, that the sclerosed exudate may interfere with brain development and account for the attacks of migraine which are observed in children after the least exertion, defects in memory or arrested intelligence. They quote Klippel and other authors who associate forms of general juvenile paralysis and dementia praecox with these forms of tuberculous meningitis.

P. Vignard and L. Thievenot[60] from clinical histories and operative findings conclude that renal tuberculosis in children has the same anatomical lesions as in adults. The clinical diagnosis is often difficult, as the symptoms are misleading and the disease is often mistaken for stone in the bladder, cystitis, malignant tumor or simple incontinence. Bacteriologic examinations and animal experimentation are always necessary to establish a diagnosis.

### PROGNOSIS

61. Hahn, H.: Prognosis of Tuberculosis in Infants. Monatschr. f. Kinderh., 1912, x, 53.

62. Koplik, H.: Tuberculosis in Infancy and Childhood. Bull. Johns Hopkins Hops., 1912, xxiii, 254.

63. Eichelberg: Contribution to the Study of Tuberculosis in Infants. Monatschr. f. Kinderh., 1912, x, 12, p. 668.

64. Ibrahim, J.: Prognosis of Tuberculosis in Young Infants. Beitr. z. Klin. d. Tuberk., 1912, xxi, 2, p. 117.

H. Hahn[61] feels that the prognosis of tuberculosis in children is much better than is generally believed; a small number of infants affected with the disease survive, while those who die live longer than was formerly supposed.

The prognosis depends on the time of infection, the clinical course and the localization. Thus children who remain free of fever, in whom there is an increase in weight, in whom the process remains localized in the eye, glands, bones and joints, usually recover. While those in whom

there is a tendency to generalization or a wide-spread process in the lungs, usually die.

The prognosis depends largely on the source of infection and the condition of the individual from whom the infection originates. A virulent type of the disease gives rise to a virulent type in the person infected from this source. Of importance is the opportunity for repeated infections and the number of infecting bacilli.

According to this writer, children who outlive the infection, do not show a specific "tubercular habitus."

According to H. Koplik,[62] the prognosis of tuberculosis in infancy and early childhood is bad, on account of the tendency of the infection to spread and become general. The earliest age at which a tendency to cure has been observed is 15 months. The best prognosis is beyond the age of 7 and in the localized glandular and osseous forms.

Eichelberg[63] reports the following case which substantiates Hahn's statement that the prognosis of tuberculosis in infants is not absolutely bad: The 4-month-old baby of a tuberculous mother was taken to the hospital because of an intestinal disturbance. Below the lower jaw was an indolent, hard, round swelling in the subcutaneous tissue, not adherent to the skin. A v. Pirquet reaction was markedly positive. The intestinal disturbance cleared up, but the gland increased in size and finally suppurated. There was final recovery after injections of 10 per cent. iodoform in glycerin.

No other tuberculous lesion could be demonstrated.

The following case of J. Ibrahim's[64] also illustrates the fact that tuberculosis in infants is not always fatal. A woman with advanced tuberculosis gave birth to a child who at 5 weeks was taken from her and placed in a home where there was no chance of infection. When the child was 6 weeks old the v. Pirquet test was negative, but became positive shortly after. When the infant was 7 months, a tubercular eruption developed and a tubercular gland at the angle of the jaw. At 15 months the child had a phlyctencular keratitis. After that it developed well and showed no evidence of a tubercular habitus or "exudative diathesis."

## PROPHYLAXIS

65. v. Leube: Prophylaxis of Tuberculosis in Childhood. München. med. Wchnschr., 1912, lix, 31 and 32.

66. V. Ruck, K.: A Practical Method of Prophylactic Immunization Against Tuberculosis. Med. Rec., New York, 1912, lxxxii, 9, p. 370.

67. Philip, R. W.: Tuberculization and Detuberculization. Brit. Med. Jour., 1912, i, 873.

68. Pottenger, F. M.: The Relationship Between Infection in the Child and Clinical Tuberculosis in the Adult. Am. Jour. Dis. Child., 1912, iv, 1, p. 13.

69. Blum, C.: Facts Suggested by Examination of Children of Tuberculous Patients. New York Med. Jour., 1912, xcv, 25, p. 1323.

70. Delepine, S.: The Probable Effect of Control of the Milk Supply upon Infantile Mortality from Tuberculosis. Lancet, London, 1912, i, 21, p. 1424.

71. McCarthy, F. P.: Influence of Race in the Prevalence of Tuberculosis. Boston Med. and Surg. Jour., 1912, clxvi, 6, p. 207.

72. Chadwick, H. D.: Open Air Rooms. Boston Med. and Surg. Jour., 1912, clxvi, 22, p. 810.

73. Ober, R. B.: Open Air Rooms. Boston Med. and Surg. Jour., 1912, clxvi, 22.

74. Editorial: Outdoor Classes for Tubercular Children. Jour. Am. Med. Assn., 1912, lix, 13, p. 1206.

75. Wolf, F.: Colonies for Children Threatened with Tuberculosis. Ztschr. f. Tuberk. u. Heilstättenw., 1912, xix, 2, 9, 190.

76. Haberlin, C.: Sea Side Hospitals for Children. Ztschr. f. Tuberk. u. Heilstättenw., 1912, xviii, 5, p. 446.

In discussing the question of prophylaxis of tuberculosis, v. Leube,[65] although he admits the possibility of an intra-uterine infection, emphasizes the fact that in most instances children are born free of tuberculosis and acquire the infection later. The fact is substantiated by the v. Pirquet test and autopsy findings. A positive v. Pirquet reaction and tuberculous findings at autopsy are rare the first year of life, even when the mother is tuberculous, but their frequency increases steadily to the age of puberty; but in tuberculosis, whether acquired before or after birth, prophylactic measures should be directed toward the same end, namely, to inhibit the deleterious action of the bacilli which have already entered the body and to protect the child from new infection or limit to a minimum. Even if infection has already taken place, protection must be made against reinfection, for immunity in man, as has been shown experimentally in animals, is only relative, and reinfection takes place after exposure to a massive infection.

Then, because of this possibility of congenital infection and because of the high mortality of children from tuberculous mothers, v. Leube advises forbidding the marriage of tuberculous girls and women, not only those with active processes, but those with latent forms, for there is always the danger of pregnancy awakening the process. In case a tuberculous mother gives birth to a healthy baby, v. Leube strongly advises against her nursing it, for latest researches and experience teach that the milk of tuberculous mothers may contain tubercle bacilli, even if the disease does not affect the mammary gland. The question of how a newborn baby should be protected from its tuberculous surroundings has two solutions. Either the infection matter should be rendered harmless by hygienic rules—disinfection and prevention of dissemination of sputum, forbidding the children from crawling on the dirty floor, forbidding the use of dirty dishes, kissing, etc., or the tuberculous individual or the child should be removed from the home. If neither of the latter is feasible, the child could be isolated in the home, and when old enough, sent to one of the fresh-air schools, where he will be not only protected against infection, but receive good care and nourishment.

The writer believes there is great need for fresh-air institutions for children. Seaside hospitals are valuable aids in the fight against tuberculosis in children.

V. Leube believes that tuberculin should be given to children of tuberculous parents. He advised that a v. Pirquet test be frequently made, in order to determine the earliest time of infection, and as soon as a positive reaction is obtained, the tuberculin treatment should be given. He begins with 1/1,000 mg. and gradually increases the dose.

If a child acquires an open tuberculosis, it should be sent to a suitable institution.

R. W. Philip[67] outlines a plan which he believes would solve many of the tuberculosis problems. He believes that in every community there should exist a center to concern itself in the widest possible way with the facts of tuberculosis as they exist in the area. Here should be directed all inquiries regarding tuberculosis. Here should come patients in all stages of the disease and persons who are anxious lest they be tuberculous. Each case should receive appropriate guidance and direction, either at the center itself or at one of the institutions with which it should be allied. Patients should be sent to sanitariums or hospitals or farm colonies, as the case demands. The tuberculous school child should be transferred to a special school for tuberculous children in close relationship with the center itself, or with the sanitarium or farm colony, so that during the process of cure mental development may not be interrupted. When the time comes for patients to be discharged from these several institutions, they should be referred back to the center for medical superintendence and after-care.

F. M. Pottenger[68] answers the question, What is the subsequent history of the child who received a tuberculous infection before the fifteenth year? He says a small percentage develop the disease and die soon. Another small percentage develop chronic tuberculosis, another shows definite symptoms of tuberculosis. The great majority remain free from symptoms and normally develop.

Pottenger quotes from a previous paper in which he showed that observation, both clinical and experimental, warrants the assertion that one who has tuberculous lesions already present in the body develops a protection against further inoculation with bacilli, and if extension of the old process or a new infection occurs, it must be through sufficient bacilli to overcome this immunity.

The preponderance of clinical evidence throws clinical tuberculosis in adults back to early infections of childhood. Therefore, the disease must be stamped out by making the individual immune to infection, or by curing the infection when it occurs and so prevent it from reaching the open stage. It is the physician's duty to seek out infected children

and put them on a hygienic régime, which favors physical development. Those showing active disease should be treated with tuberculin.

In the Gouverneur Tuberculosis Clinic an attempt has been made to examine all children directly exposed to the infection. G. Blum[69] reports the results as follows: One hundred and ninety-six children were examined. Forty (20.4 per cent.) were found to be tuberculous; 156 were apparently not tuberculous, but 113 of these needed medical or surgical care. The importance of examining children exposed to tuberculous infection lies not only in detecting signs of tuberculosis, but also in detecting anything which lowers the child's resistance. The correction of defects like thoracic malformation, the removal of obstructions to air passages, may to a great extent modify bad heredity and give the child a chance to grow into a vigorous and useful individual.

S. Delepine[70] describes the method of controlling the milk-supply which was adopted in Manchester, England, to reduce the infant mortality from tuberculosis.

Milk arriving in town from various farms is frequently tested by inoculation experiments and, if found tuberculous, a veterinary inspector visits the dairy, examines the cows and takes milk from suspected cows. These samples are again tested by inoculation experiments and the farmer is requested to isolate any cow found to produce tuberculous milk and to have it slaughtered as soon as possible.

By this procedure the quantity of tuberculous milk has been reduced to one-third of what it was fourteen years ago; moreover, the infant mortality rate has dropped much faster than in other cities of England.

F. P. McCarthy[71] believes that racial variations in immunity and susceptibility play a rôle in the prognosis of tuberculosis and teach a lesson in the methods of its attack and control. Clinical and pathological observation on the different races point to resistance by certain ones, as a result of contact with tuberculosis over a long period of time. The contact has been brought about by urbanization. The Indian and negro races have as yet acquired but slight resistance and can be protected only by preventive measures. Among the Irish also the high mortality could be brought to a considerable lower level by educational and preventive measures.

That it is possible to raise the resistance of a race is shown by the relative low mortality of the Jewish people compared with the high rate among aboriginal tribes. Without doubt this lowered mortality rate is due to an immunity handed down from generation to generation and acquired by centuries of urbanization and exposure to infectious diseases. Centuries ago the Jews undoubtedly succumbed to this disease as readily as the negro does.

H. D. Chadwick's[72] idea of a modern school building is one in which every room is open on at least two sides. In large cities this could be arranged in a building formed with a hollow square, with a large court yard in the center. The upper sash of each window should be muslin instead of glass. Heat could be procured by sufficient radiation under the windows to keep the room about 60 F. Under such conditions teacher and children could be comfortable without the burden of heavy clothing.

A committee on the prevention of tuberculosis of the Charity Organization Society of New York City[74] has assisted in the organization and maintenance of fresh air classes in the public schools.

As a result of the activity of this committee there are now eight fresh air classes in the public schools of Manhattan and the Bronx. Some of these utilize the roof, others an adjoining park pavilion, the rest making use of class-rooms in the school buildings, which have been suitably altered.

The board of education provides the meeting place for each class and an equipment of movable desks and seats. In addition it furnishes each child with a "sitting out bag," a sweater, cap, a pair of mittens, a pair of felt shoes, and a reclining chair. This equipment costs $8.39 for each child. It belongs to the school and is passed from one child to another after proper disinfection. The outfits are numbered to insure each child having his own articles as long as he is in the class, and when not in use they are kept in sanitary lockers in the class-room. The Board of Education also supplies for each class an anthropometric scale costing $19.

The committee on the prevention of tuberculosis assumes the responsibility for feeding the children.

As to the plan of selecting the children for the fresh air classes, the physician of the committee picks out all the anemic-looking children from the school. Of these are selected about forty who show the greatest percentage below proper weight. Twenty-five of these are chosen for fresh air classes on the basis of a hemoglobin test. After securing special permission, the selected children are carefully examined for carious teeth, enlarged tonsils, or lymphatic glands, and adenoids. A record is also made of the blood-pressure, and an accurate weekly weight chart is kept.

Striking results have been obtained in the first year of the system. Physical and mental improvement was the rule. In one class over half the children advanced in their school work faster than the normal rate. Control examinations showed marked physical gains of the fresh-air children as compared with children of apparently the same type in the regular classes.

The successful management of fresh-air classes as outlined is an excellent illustration of the beneficent results of the application of modern medical science to practical hygienic and eugenic problems.

F. Wolf[75] emphasizes the fact that infants and children often become infected with tuberculosis before it is realized that there is a source of infection in the home; so removing only very sick individuals to institutions does not altogether do away with the source of contagion. Wolf thinks, however, that if all children threatened with tuberculosis were removed to colonies or forest schools, much would be accomplished in reducing tuberculosis among children. By children threatened with tuberculosis are meant those who give a positive v. Pirquet reaction; those who are subject to catarrhal affections; those with scrofula; those who convalesce slowly after the acute infectious diseases.

The plan of a colony for such patients is sketched.

TREATMENT

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J. Petruschky[77] is of the opinion that good results and finally a cure can be obtained with any of the tuberculin preparations, provided physi-

cian and patient are persistent and the treatment is carried out intelligently. He uses the following preparations:

1. Koch's old tuberculin; Koch's T. O. (original tuberculin); Koch's B. E. (bacillus emulsion); Koch's A. F. (albumin free tuberculin).
2. Spengler's P. T. O. (perlsucht tuberculin).
3. Landmann's Tuberculol.
4. Beraneck's Tuberculin.
5. Deny's Filtrate (identical with T. O., Koch)

The only two methods of giving these preparations are the subcutaneous and inunction methods. Inunctions of tuberculin have been extensively used by the writer at intervals of one or two days. He recommends it not only as the method of choice for children and weak adults, but for all patients with open tuberculosis and tuberculous peritonitis. He dilutes the tuberculin with glycerin and twice a week has one or two drops rubbed in until the material disappears. He varies the site of inunction and, if inflammation sets in, uses a lanolin salve.

In general, the subcutaneous is the most reliable method and the one to be recommended. The initial dose must be one which will not produce a reaction. Even if the albumin-free tuberculin is used it is best to begin with 0.01 mg. In case of no reaction it can be increased as follows: 0.05—0.15—0.5—1.00 mg. at two- or three-day intervals. If no reaction follows the last dose of this can be increased until a *"stich-reaction"* occurs, when this dose is repeated after a week's interval and given in another place. The best criteria of correct dosage and length of interval between doses are, restful nights, good appetite and gain in weight.

It is never necessary to cause temperature reactions, so patients can be treated in ambulatory clinics.

If an intercurrent disease supervenes, the tuberculin must be stopped and not begun again until the loss of weight is regained.

Although many of the authorities advise giving the tuberculin until a cure is established, Petruschky has had better results in giving two or more courses of treatment at stated intervals. He usually gives two courses a year, one in the summer and one in the winter. He says that there is no maximum dose, and does not believe that large doses are necessary to establish a cure. He emphasizes the fact that treatment must be suited to the individual to obtain good results.

The length of time between the courses of treatment cannot be definitely stated. The best time is when there ceases to be any improvement after the first course and the sensitiveness to tuberculin, as is ascertained by a diagnostic test, returns.

For the second course it is well to use a different preparation, to begin with a very small dose, and to increase until a *"stich-reaction"* appears.

Petruschky says there is no absolute test for deciding that the disease is cured, so the time of ending the tuberculin treatment cannot be arbitrarily determined. The only safe way is to keep the patient under observation for years and, if there is no recurrence after an intercurrent disease or childbirth, the patient can be regarded as cured. Examination should be made first every three months, later every six months, and a cutaneous test given. However, a positive cutaneous reaction does not necessarily mean that the tuberculin should be recommended. If there are no other symptoms of the disease the patient is kept under observation and the reaction the next time is often found less marked. If it becomes more marked the indication is for another course of treatment with tuberculin.

For treatment with tuberculin J. Cronquist[78] considers the following points in the patient's condition. The pulmonary changes must not be so advanced that cavities have formed; but it is not necessary that they be limited to one or two lobes, for the author often successfully treated children who had changes in three lobes. The temperature, he finds, must be normal and it is important that this should be determined for two weeks, while the child is not in bed. That the temperature curve does not show marked elevations or drops, is also important. Any irritation of the skin is a decided contra-indication, for with such irritation the author has seen not only albuminuria, but true nephrites develop during the tuberculin cure. Every day, too, he examines the urine.

High temperature can be brought to normal by the fresh-air treatment and the use of a 10 per cent. creosotal in yellow cod-liver oil. Sixty to 100 gm. can be given every day to children from 3 to 5 years old.

As the initial dose Cronquist gives 0.00001 gm. of tuberculin. He usually increases it in the following proportion: 1, 2, 5, 7, 10 and sometimes more slowly, especially for children susceptible to tuberculin, as scrofulous children are. With these he begins with 0.0000001 to 0.000001 gm., and always increases with a fraction of the original dose, one-half, one-fourth, or even one-tenth. The treatment is more easily carried out, when the dose is not rapidly increased. If fever appears after an injection, it is best to reduce the dose ten times and then to increase more slowly. If the dose is carefully increased, progress is more steady, and the maximum dose can be reached without any reaction and repeated, until the tuberculous process is cured. In his cases Cronquist found that not only the final dose, but also the length of time this final dose was used, did not greatly vary. Frequently, however, he has seen young, weak, poorly-nourished children with wide-spread pulmonary changes cured by small doses which were repeated only a few times; while well-nourished children with slight pulmonary changes did not improve when large doses were given often. It is impossible, he finds, to give a standard for

all cases. Not the age, or sex, the localization of the tuberculous process, the intensity of the v. Pirquet reaction, nor the reaction curve give any help in this regard.

For a number of years Cronquist has tried to find a criterion for the highest dose of tuberculin by determining the amount of antituberculin in the blood. Engel and Bauer showed that the antituberculin content of the blood is directly proportional to the amount of tuberculin injected; the author discovered that it depends on the progress of the pulmonary lesion also, and as this subsides the antituberculin content diminished, even with large doses of tuberculin. He regards that dose optional which, when repeated, will not cause an increase, but the gradual disappearance of antituberculin from the blood. When this disappearance is complete he feels it is time to stop treatment and that the patient is cured. In his hands this dose was usually between 0.2 and 0.5 gm.

D. Kurdjumoff[79] has treated twenty-four patients varying in age from 10 to 17 years, and suffering from latent or incipient phthisis, with tuberculin purum. The initial dose was 1/100 milligrams increased to 1/10 at three- or four-day intervals or seven to ten, if there was a rise in temperature. The results were very satisfactory. The writer drew the following conclusions from his study:

1. The use of tuberculin purum in latent or incipient tuberculosis of young individuals is harmless with careful dosage.

2. Except for insignificant rise in temperature, no manifestations of a general reaction were noted.

3. *"Stich-reactions"* were rare and occurred in the form of slightly painful swellings, which disappeared in a few hours.

4. High temperatures were no contra-indication for the treatment, nor were poor nutrition or anemia.

5. The results were far superior to those obtained by hygienic dietetic treatment.

H. Wittich[80] treated sixty tuberculous children in H. Heubner's ambulatory clinic with tuberculin. He began with 1/1,000 mg. and gradually increased to 20 mg. The injections were given twice a week, usually into the forearm. No child who had a temperature above 37.5 C. was injected.

At the beginning of the course of treatment the mother was instructed how to take the child's temperature, and was given a paper on which to keep note of the results, as well as the facts concerning appetite, cough, pain in the side, night-sweats, and general condition. Once a week the children were weighed at the clinic.

The children treated showed the clinical picture of scrofula or of incipient tuberculosis, which usually began with a bronchial gland tuberculosis.

The results in the scrofulous children were especially gratifying. The scrofulous stigmata, the tubercular phlyctenules and skin tuberculides disappeared. There was improvement in the appetite and general condition and an increase in weight.

The results were also gratifying in the cases of incipient tuberculosis. The temperature curve was more uniform; instead of varying in a few hours from 36 C. to 38 C., it approached normal or 37 C. The appetite and weight curve, and the diarrhea, which often is so obstinate, improved and the cough and night-sweats disappeared.

Frequently, as the dose of tuberculin was increased, a *"stich-reaction"* appeared, and Wittich took this for an indication to stop the treatment. Further evidence of the good results of the treatment was the statement of the mothers, who thought the children seemed quite different than before, brighter and wider awake.

P. J. Mitchell[82] treated eighteen cases of pulmonary and osseous tuberculosis in children with Marmorek's antituberculosis serum. The children received 2.5 c.c. subcutaneously every day until local anaphylactic manifestations appeared. Then they received 5 c.c. per rectum for two or three weeks. After a pause of seven to ten days the same procedure was repeated, and again repeated as long as the case demanded. The results were not striking. There was a noticeable improvement in the general symptoms, but the local pulmonary signs were not influenced. In cases of osseous tuberculosis an improvement was noted, but this did not take place more quickly than under the usual surgical procedures.

Lately a new method of treating pulmonary tuberculosis has been instituted, namely, the production of an artificial pneumothorax. This is done, according to C. Lillingston,[83] either by the Forlanini or puncture method, or by the Murphy or open method. The first consists of introducing nitrogen through a fine hollow needle into the pleural cavity. Care must be taken that the needle does not enter a vein. The other consists of dissecting down to the costal pleura, which, when exposed, is punctured with a blunt canula. Nitrogen is admitted through the canula under manometric control.

Extensive and acute disease of one lung coupled with slight or no disease of the other is the usual indication for this treatment; but in certain circumstances it is advisable to induce an artificial pneumothorax on one side, even if there is considerable disease on the other.

The two chief dangers from the operation are pleural reflex and gas embolism; the chief complications, effusion into the pleural cavity and surgical empyema.

If complete collapse of the lung is obtained, the temperature falls to normal, there is a gradual gain in weight and strength, the cough ceases and expectoration and night sweats disappear. The disease is perma-

nently arrested in most cases, but it sometimes flares up again, if compression of the lung is not maintained long enough.

F. Pielsticker and H. Vogt[84] report their experiences in treating six cases of pulmonary tuberculosis and four of bronchiectasis with artificial pneumothorax. The children were from 15 months to 14 years of age. The Brauer puncture method was the one chiefly employed, and in eight instances the pleura was entered without difficulty; in two it could not be entered because of adhesions. It was astonishing to see the tolerance with which the children bore the shutting off of the entire lung.

The results in the cases of bronchiectasis were disappointing. Adhesions prevented the collapse of the lung in certain areas and the object of treatment was defeated, namely, by compression to put the entire lung at rest.

In the cases of tuberculosis the outcome was excellent. In most of them the disease took an unhoped for turn for the better. In two cases the condition had been regarded as absolutely hopeless before the treatment with the pneumothorax was begun.

W. Spitzmüller and H. Peterka[85] have been using heliotherapy as an adjuvant to other measures in treating the children at the Public Children's Hospital in upper Austria. They were unable to detect any marked influence from its use. The children from the Vienna slums recovered from tuberculosis in the pure country air and with the good food, regardless of systematic exposure to the sunlight. The authors urge that classified records be kept of results obtained among patients treated by the ordinary methods alone and among those treated with heliotherapy in addition, and those treated with heliotherapy alone.

G. Austin[83] describes the treatment of surgical tuberculosis employed by Rollier at Leysen, Switzerland, at an altitude of 5,000 feet. The method consists of exposing the body of the patient to the sun's rays in open galleries communicating with the wards and facing south. At first the actual seat of the disease is uncovered for five minutes only, as there must be no blistering or burning of the skin; the next day the region is heated for two periods of five minutes each, separated by an interval of half an hour; and on the third day these exposures are lengthened to fifteen or twenty minutes. At each seance a larger area of skin is uncovered, so that by the end of a week or ten days the entire body, the head excepted, is lying nude in the sun, even in midwinter. The head has to be protected for some time longer, to prevent congestion, but it, too, is ultimately brought to tolerate the sunlight. The patients are wheeled out in their beds as soon as the sun appears in the morning and lie there naked for hours under the influence of its healing rays, and are only moved back into the house when the cool night air begins to make itself felt. According to the necessities of the case the patient is partly or

entirely immobilized until the actual disease is cured, and only in cases in which it is absolutely essential, is an apparatus applied to correct deformities or straighten limbs. In those cases in which a plaster cast cannot be dispensed with, an opening as large as possible is cut at the seat of the trouble, so that this part can still be exposed to the sun's rays. When in spite of the treatment an abscess seems about to open, it is punctured and the pus drawn off. When an abscess has already opened and is infected on presentation of the patient for treatment, the cavity is scraped and disinfected and then exposed to the full light of the sun. A small antiseptic dressing is applied at night.

In consequence of the favorable results obtained with heliotherapy in surgical tuberculosis of children, O. Bernhard[87] has limited operative treatment to puncture, iodoform injections and small incisions, curetting or atypical osteotomy. He uses the local sun baths, as he believes the patients can stand them better than the general exposure. In severe cases of tuberculosis of the spine or hip, he combines heliotherapy with extension and immobilization.

In the sanitariums of mountainous regions, where the sun does not shine for days of weeks, the author suggests that a Finsen light apparatus should be used as a substitute for the sun's rays.

A. Hoffman[88] reports four cures of tuberculous peritonitis treated by painting the peritoneum with tincture of iodin. The patients were women of 23 and 30, a girl of 15 and a child of 6. The child of 6 had just recovered from a right-sided pleurisy. Râles were audible over both lower lobes, the abdomen was distended with fluid and slightly tender, the temperature was 38 C. Laparotomy showed numerous cheesy tubercles, the loops of intestine adherent and bathed in fluid.

The entire abdominal space was painted with iodin. After the operation the child vomited several times and the abdomen was very tender, but the meteorism and ascites gradually subsided, and in three weeks the child was permitted to get up. The râles disappeared and during the year since the operation the child has been apparently well. The rapid subsidence of the pulmonary symptoms in this case suggests a specific action from the iodin.

In tuberculous peritonitis in children, M. Klotz[89] has had good results from repeated punctures of the peritoneal cavity. This treatment is indicated if the fluid does not disappear when the patient's diet has been regulated, and he has been exposed to the sun's says, made to rest in bed and given diuretics, and if there is a tendency for the fluid to increase at each puncture, as much fluid as possible is withdrawn and a compression bandage applied.

E. Perier[90] cites the good results obtained in tuberculous peritonitis with a non-fluid, salt-free diet. A wet compress covered with oil silk is

applied to the abdomen and the patient is put at complete rest in bed with all the windows open. Lime is administered internally. Puncture is advised if the ascites is distressing and does not clear up under this régime.

W. G. Sutcliff[92] draws attention to the fact that though primary tuberculosis of the cervical glands is rare, it is certain that the enlarged glands which follow an attack of tonsillitis furnish a very suitable soil for the development of tuberculosis. He feels strongly that the possibility of this secondary infection should be eliminated by removal of enlarged tonsils and adenoids.

It is in the early stages of tuberculous disease of the glands before caseation has taken place that rest, fresh air and proper diet give good results, and if these measures are begun early, frequently operative and vaccine treatment can be dispensed with. However, if the glands have existed for more than six months, caseation has probably begun and operation will sooner or later be necessary.

Sutcliff does not believe much benefit can be derived from the use of tuberculin in the early stages of the disease. If used, it must be given cautiously, as too large a dose will produce a serious reaction. A dose of 0.0005 mg., increased after two weeks, is not usually followed by any bad symptoms.

In the after-treatment of operative cases Sutcliff emphasizes the importance of rest. He usually keeps the child lying down for at least a fortnight, the neck being bandaged with a fairly voluminous dressing to act as a splint. Tuberculin is of some value in the postoperative treatment of tuberculous glands. The author usually waits a month after the operation and then gives it for about three months in the doses previously referred to. His impression is that thickening, if present, clears up more rapidly and infection in the neighboring areas does not take place so frequently when tuberculin is used.

E. Moro[94] was of the opinion that scrofula was a manifestation of tuberculosis in children suffering from an exudative diathesis. It would then be expected that the symptoms of scrofula would be aggravated by a diet which aggravates the exudative diathesis. As an experiment, Moro placed a number of scrofulous children on a milk and egg diet, but contrary to his expectation, no new symptoms of scrofula developed, and those present showed a tendency to heal. This was true, however, only of the children who gained in weight. Moro warns of the danger of mistaking pure exudative diathesis for scrofula, and of giving children with exudative diathesis a diet rich in milk and eggs.

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